Extreme Weather and the Risk to Critical Infrastructure

Greg Tangonan
Ateneo Innovation Center

Complexity of Cascading Disasters —-> No Easy Way to Assess Risk

We Grossly Under-Estimate the Risks / Magnitude of these MegaStorms

Simple Model of Why Infrastructure Failures Will Happen More Often

Learning From Recent Disasters and the Pandemic

We Need to Understand the Risks of Extreme Events by Analyzing Extreme Value Statistics - Reinsurance Models

New Sensor Systems for Critical Infrastructures in Extreme Weather

MDRR Class Lecture - Innovation and Technology Class Introduction

January 24, 2024

The New Normal - A Cascade of Extreme Events

Cascaded Disasters and Crises Reveal New Dimensions in the Geography of Risk and Vulnerability

philstar GLOBAL
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4 State Trucks
Freightliner & more!
Photo shows a pedestrian crossing a flooded Taft Avenue in Manila following continuous rains yesterday.
Krizjohn Rosales, file

Monsoon floods cities; thousands evacuated

Does Your COVID Timeline Include These Disasters ?

New COVID Variant Spread in NCR

People navigate the knee-deep flood in Barangay San Agustin in Malabon City

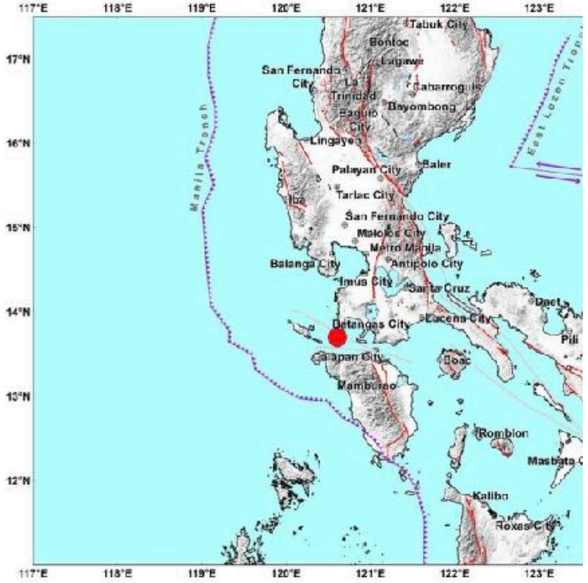
INQUIRER.NET

Magnitude 6.6 quake hits Batangas, felt in Metro Manila, nearby provinces

By: Julie Espinosa - @inquirerdotnet

INQUIRER.net / 05:22 AM July 24, 2021

July 24, 2021



We Need To Anticipate Cascading Disasters with a Whole of Society Adaptive Response

EXTREME RAINFALL HITS CRITICAL INFRASTRUCTURE

Hong Kong and southern China battle widespread flooding from record rains

By Kelly Ng
BBC News

8 September 2023

Watch: Roads collapse and streets flood in Hong Kong

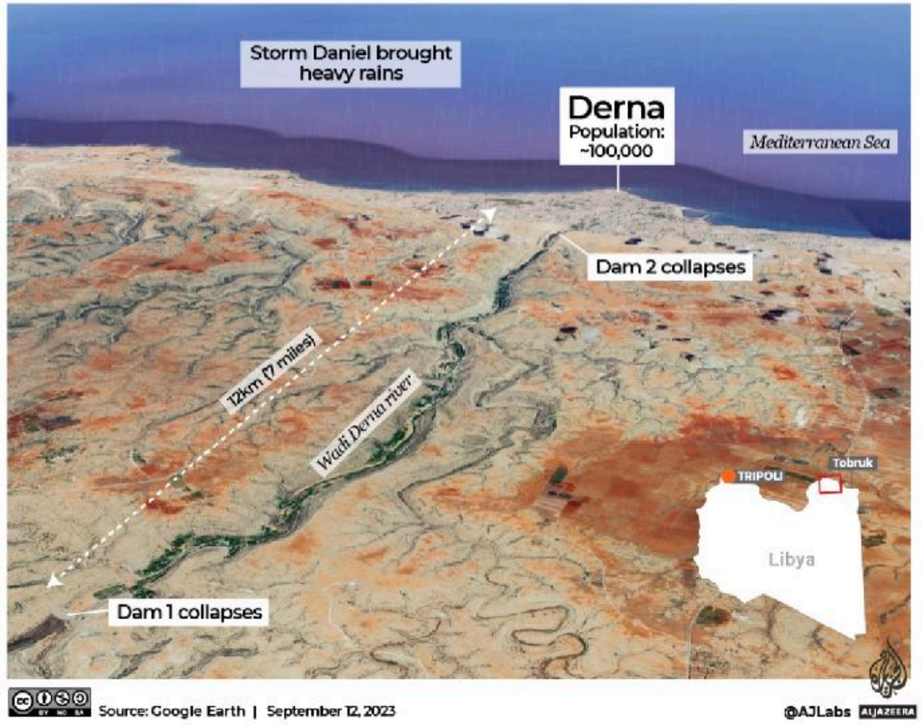
Hong Kong's weather bureau issued its highest "black" rainstorm warning early on Friday. It said more than 200mm (7.9ins) of rain was recorded on Hong Kong's main island, the Kowloon district and the north-eastern part of the city's New Territories from late on Thursday.

AGING DAMS COLLAPSED - VIRTUAL TSUNAMI HIT

LIBYA

Thousands feared dead in Libya floods

As many as 3,000 people may be dead after heavy flooding caused by Storm Daniel swept away entire neighbourhoods in eastern Libya. The city of Derna is hardest hit after two dams burst and inundated it.



"Entire neighborhoods in Derna disappeared, along with their residents, swept away by water after the two aging structures collapsed, creating a catastrophic situation that is out of control", said WFP.

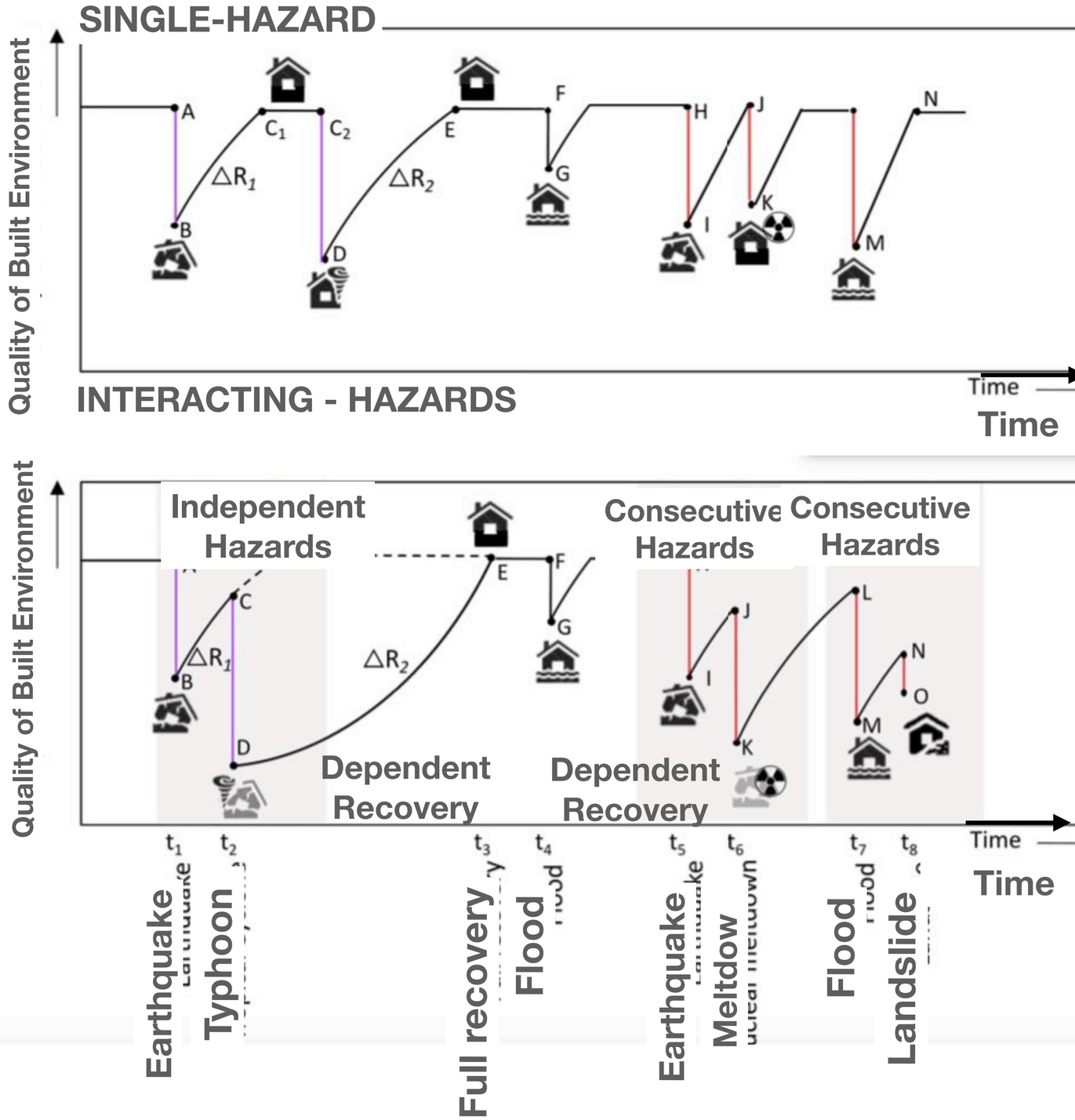
Why Is Our Infrastructure So Fragile, Easy to Fail Under Extreme Conditions ?

Why We Can No Longer Ignore Consecutive Disasters

Marleen C. de Ruiter et al,
Institute of Environmental Studies,
Vrije University, The Netherlands
DOI: 10.1029/2019EF001425

The consequences of a sequential disaster can be, for example, that a government does not have funds anymore to address a second event if the first event was very costly. The consequences of these sequential disasters are difficult to model, and it is challenging to design good policies to address the impacts of sequential disasters. In our study, we explain how these sequential disasters occur and why it is important that we address them better in our models but also in the way we design our policies.

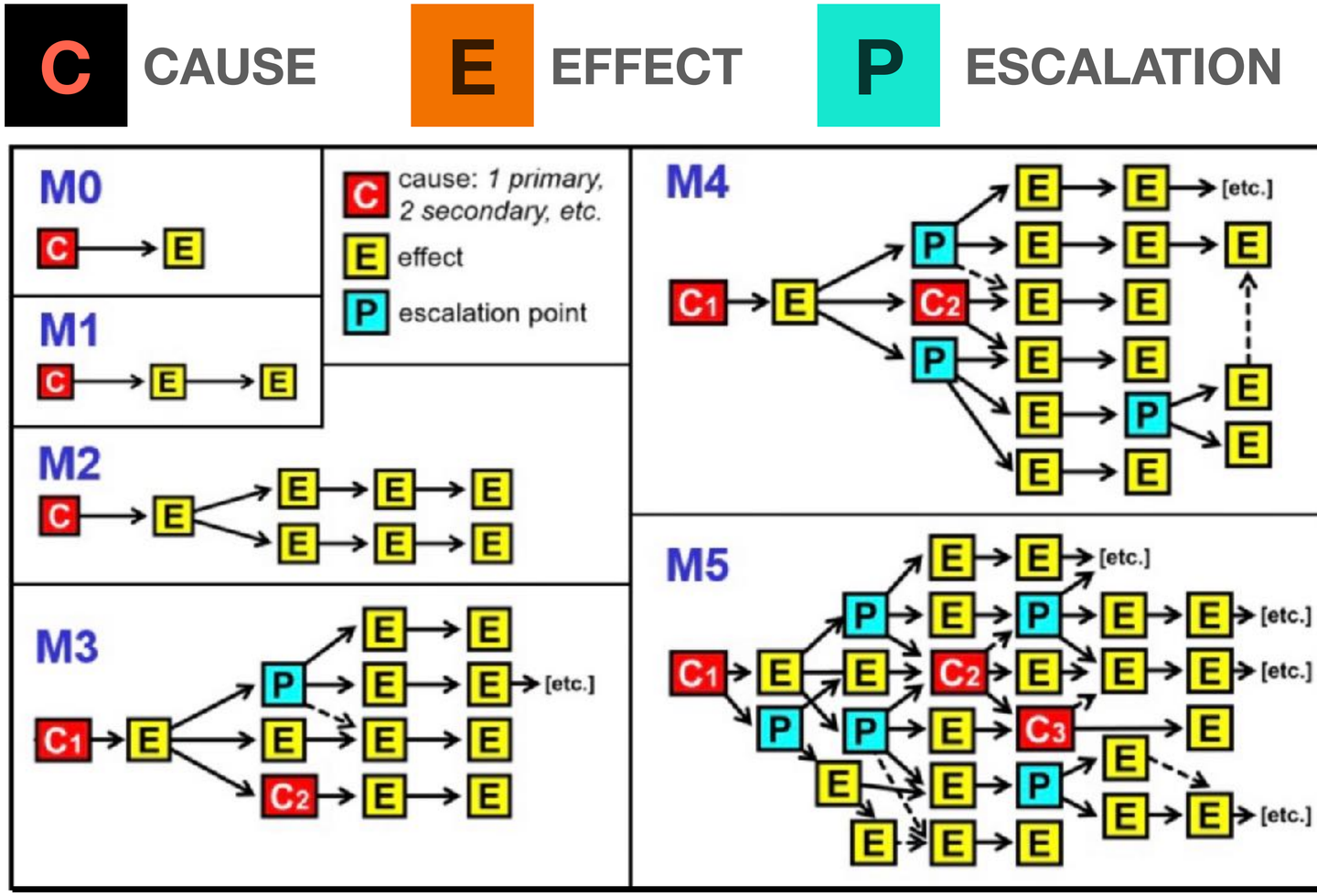
Heat Wave —> Hot Strong Winds—>
Wild Fires —> Flooding—> Landslides …



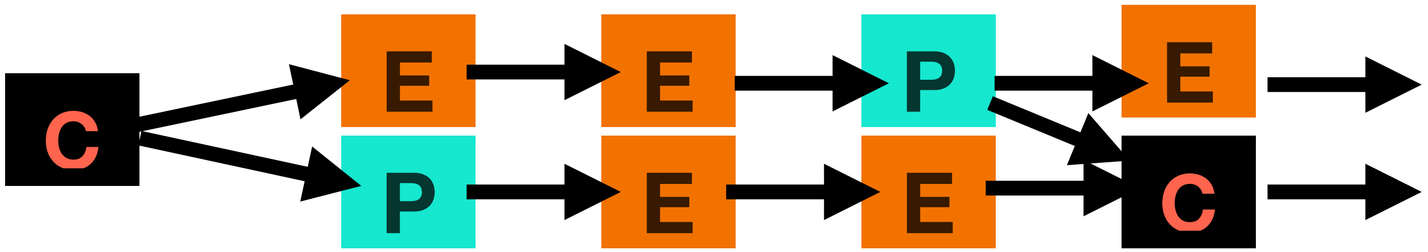
What are Cascading Disasters?

D. Alexander and G. Pescaroli,
University College London,
Institute for Risk and Disaster Reduction, UK
10.14324/111.444/ucloe.000003

Cascades have emerged as a new paradigm in disaster studies. The high level of dependency of modern populations on critical infrastructure and networks allows the impact of disasters to propagate through socio-economic systems. Where vulnerabilities overlap and interact, escalation points are created that can create secondary effects with greater impact than the primary event.



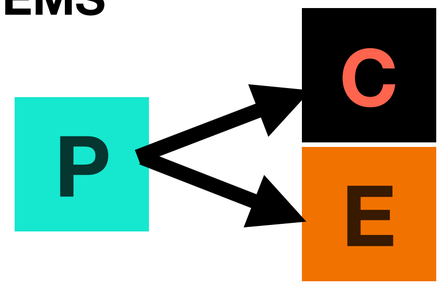
NONLINEAR ESCALATION OF CASCADING DISASTERS



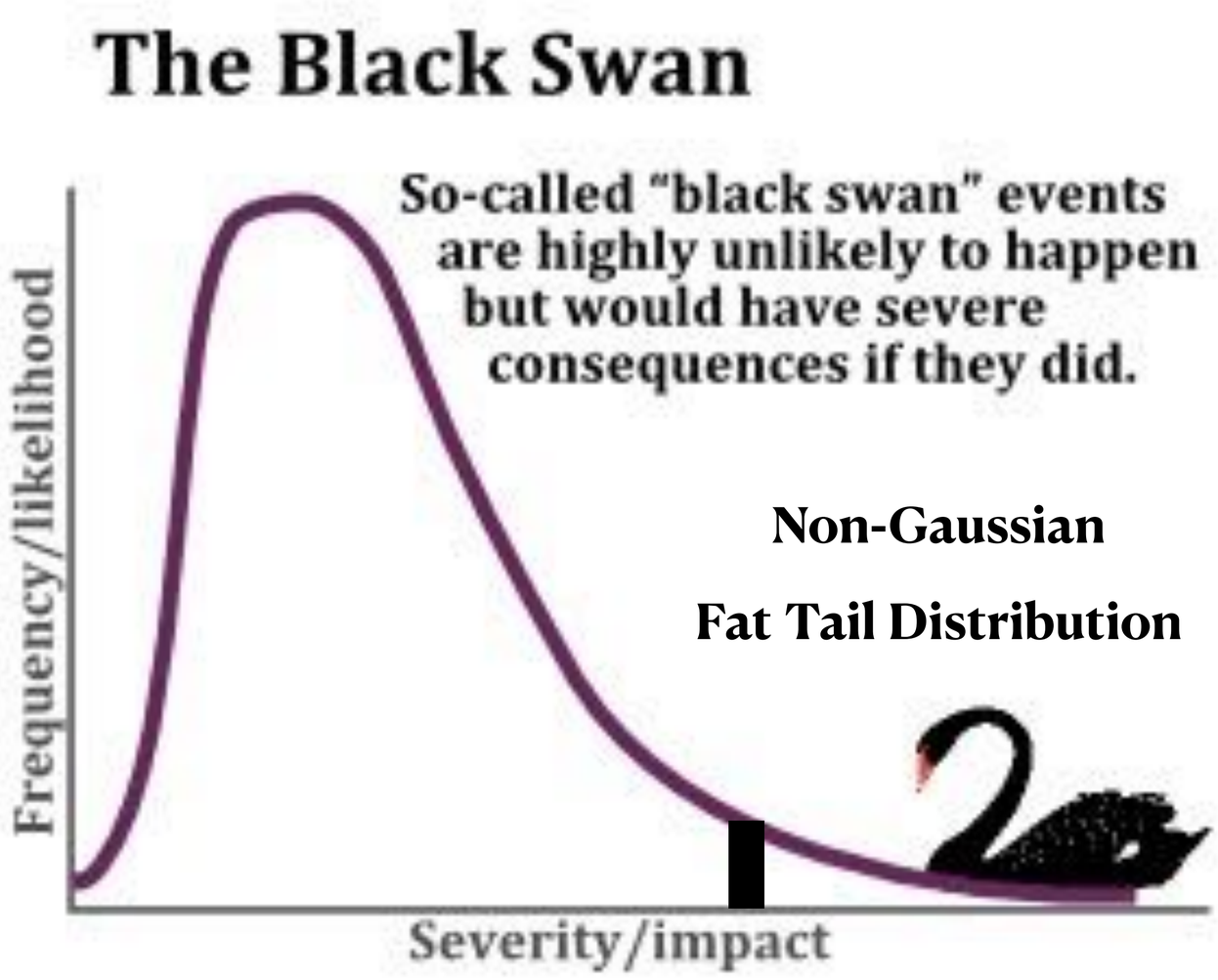
EMERGENT BEHAVIOR OF COMPLEX SYSTEMS

LOCKDOWN DESIGN

J&J VACCINE HALT



Why Extreme Events Seem to Happen More Often


The Black Swan
So-called "black swan" events are highly unlikely to happen but would have severe consequences if they did.
Frequency/likelihood
Severity/impact

Non-Gaussian

Fat Tail Distribution

EXTREME EVENTS OCCUR MORE OFTEN

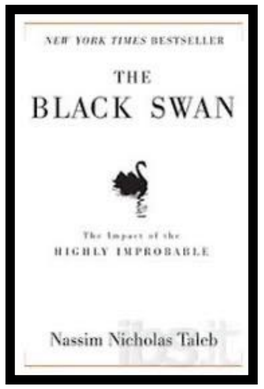
IGNORE THE PROBABILITY OF RUIN

RARE AND EXTREME EVENTS CANNOT BE IGNORED

WE TRY TO PREDICT THEM IN HINDSIGHT

PREDICTION OF EXTREME EVENTS IS VERY HARD

EMBRACE THE COMPLEXITY AND BUILD RESILIENCE

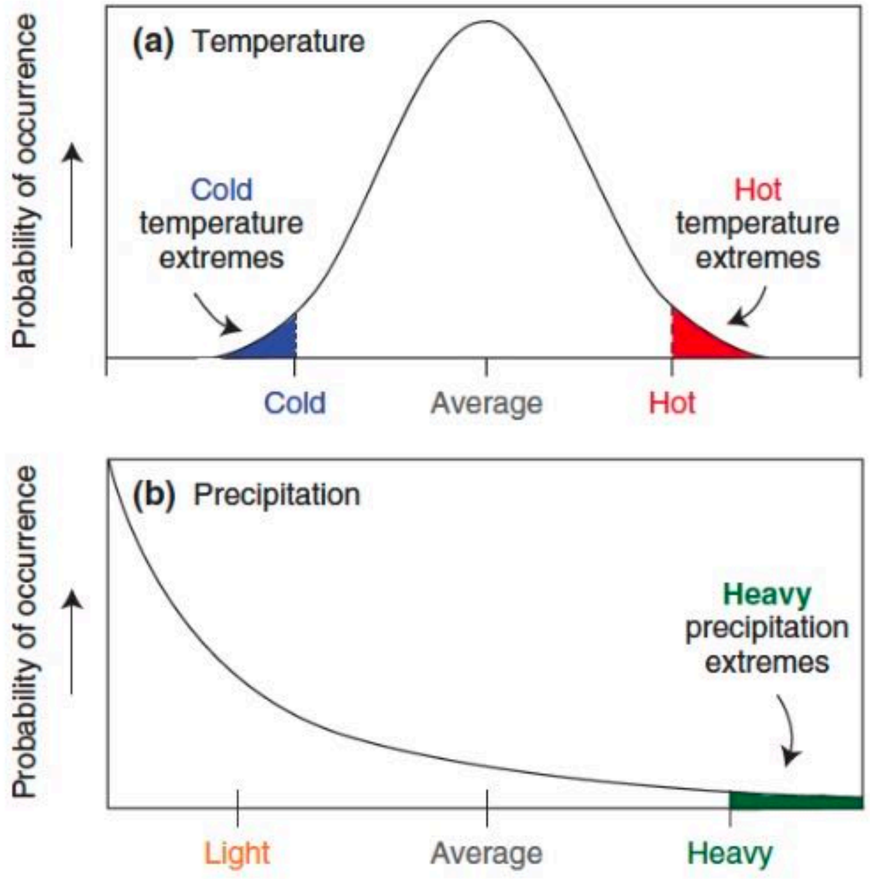


NASSIM NICHOLAS TALEB - THE BLACK SWAN

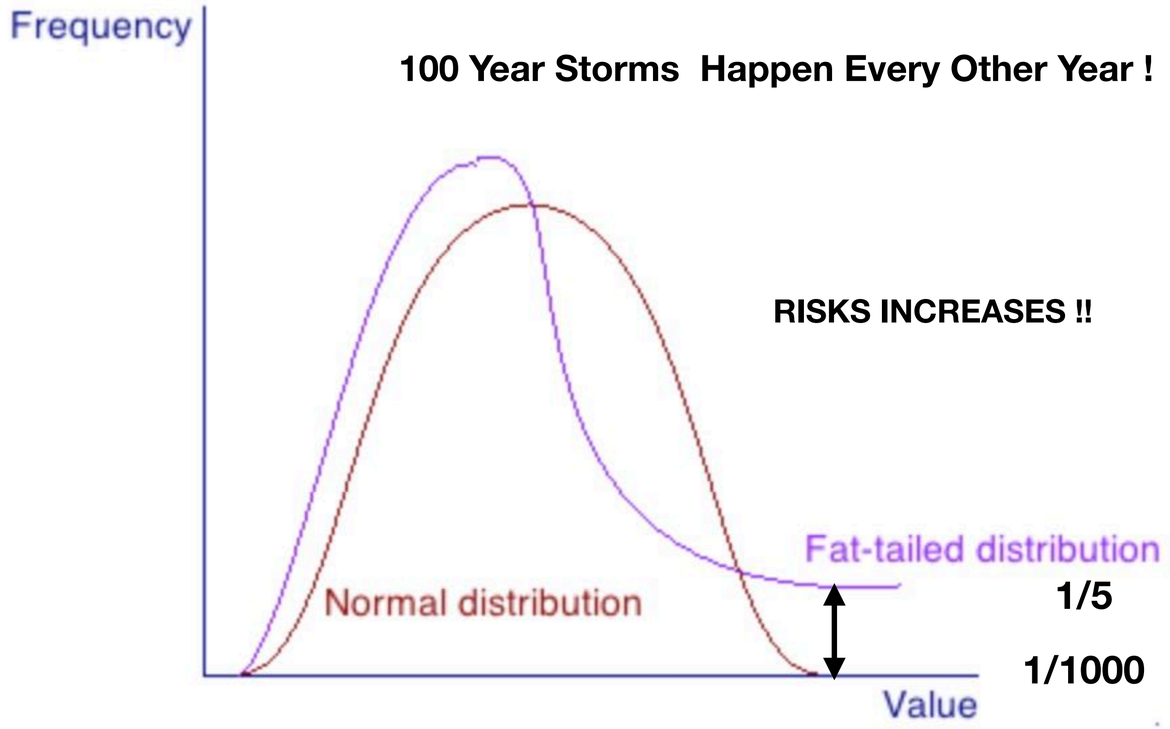
TAIL PROBABILITY IS 1/5

GAUSSIAN PREDICTS 1/500

Extreme Weather Events



Events Happen More Often



We Need To Rethink the Risks We Are Prepared to Take ?

OVER-OPTIMIZATION CAN INCREASE VULNERABILITY TO DISASTERS

EACH GRAIN OF SAND ADDED - CAUSES INSTABILITIES - AVALANCHE

cnnphilippines
Metro Manila ranks first in world's worst traffic in metro area list for 2023
Local motorists spent an average travel time of 25 minutes and 30 seconds per 10 kilometers on the roads of Metro Manila last year, which is a 50-second increase from its previous record.

When A System Achieves Certain Scale

Self-Organized Criticality —> Avalanches

Banking Systems get Hacked *Health Systems Crash* *Air Traffic Collapses in Extreme Weather* *Education Systems Crash in Pandemic*

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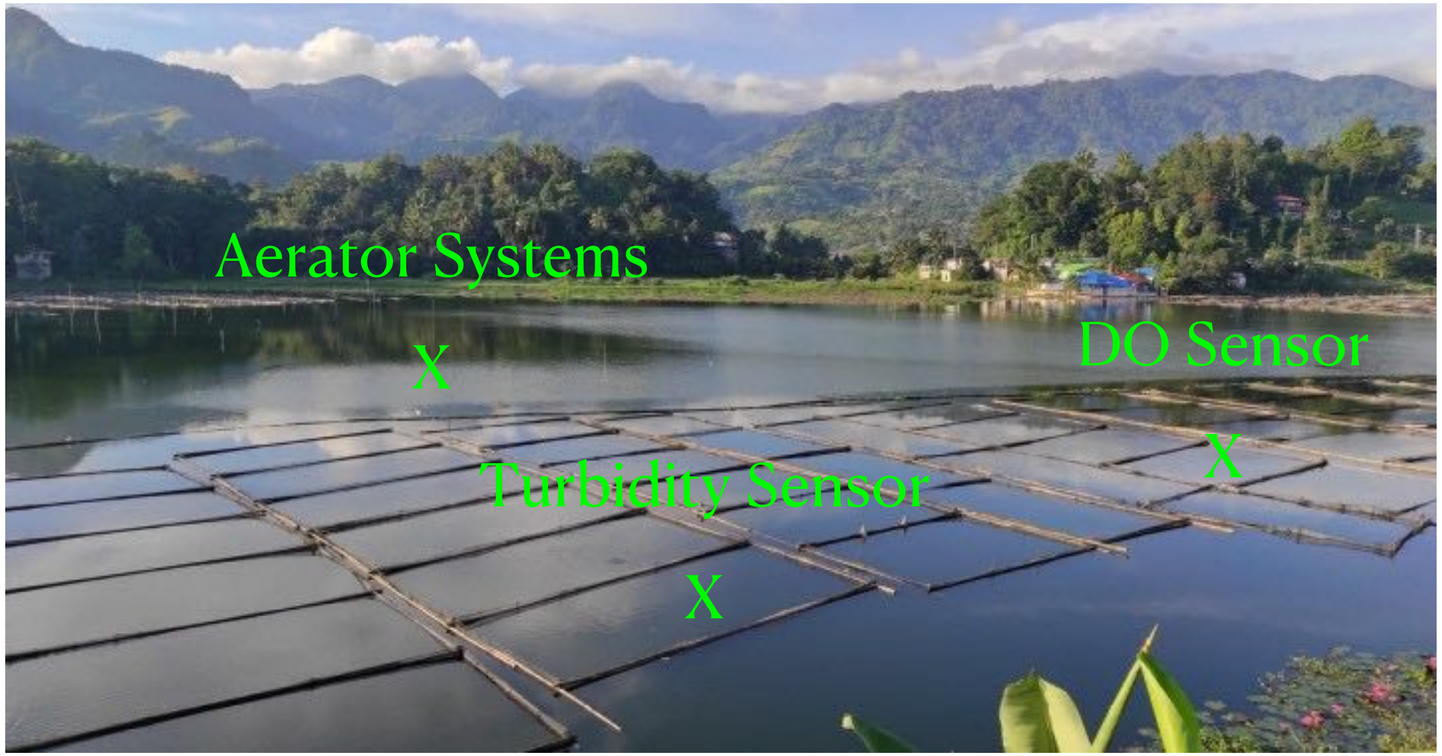
Low DO, Turbid Water, and Excess Waste Drive Fishkill

Critical Need for Sensors / Aerators and Alerts



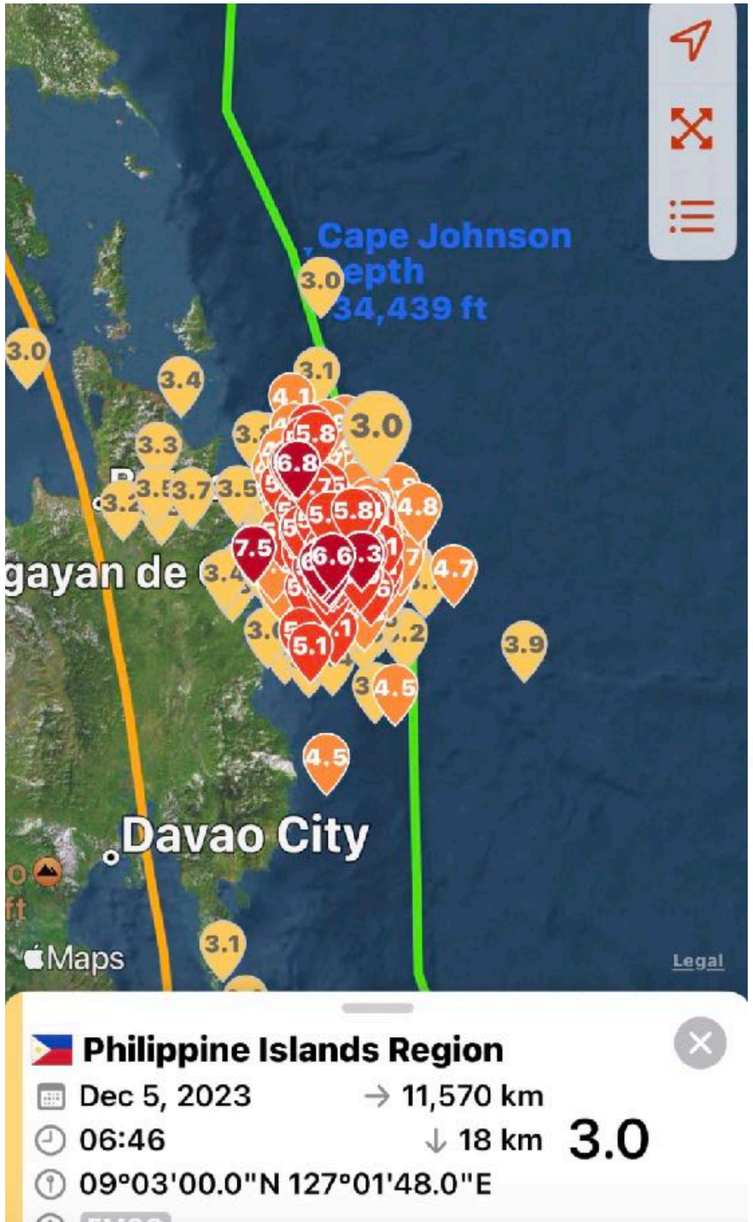
Share Real Time Data on All Crucial Parameters

Real Time Alerts for Fisherfolk during Key Phases

AI/Machine Learning for Forecasting

From Hazard to Damage to Bad Investment ?

Intensity - Space - Time Data



Damage to Recently Finished Condos

2023 EARTHQUAKE

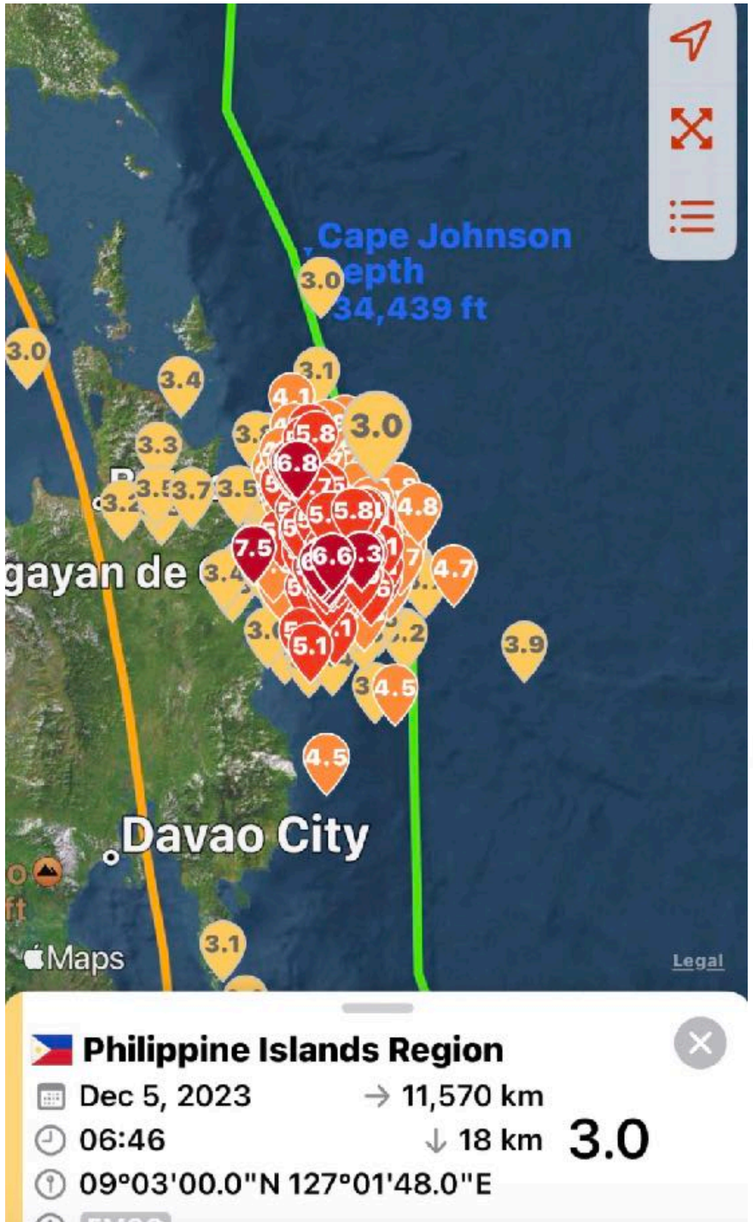
Davao

What Value Would You Put on Damaged Infrastructure ?

Would You Invest in Such Risky Infrastructure ?

From Hazard to Damage to Bad Investment ?

Intensity - Space - Time Data



Damage to Recently Finished Condos

The Himeji Building of Ecoland 4000 Residences (L) in Davao City collapses during the Magnitude 6.5 earthquake on 31 October 2019.. MindaNews photo by MANMAN DEJETO

What Value Would You Put on Damaged Infrastructure ?

Would You Invest in Such Risky Infrastructure ?

Single Point Block Causes Major Global Supply Chain Disruption

In March 2021, the Suez Canal was blocked for six days by the *Ever Given*, a container ship that had run aground in the canal.

The Guardian 20 December 2023

Shipping industry

More than 100 container ships rerouted from Suez canal to avoid Houthi attacks

Cape of Good Hope diversion adds 6,000 nautical miles and three or four weeks to delivery times and has driven up oil prices

Fragility of Shipping - Winds and Pirates

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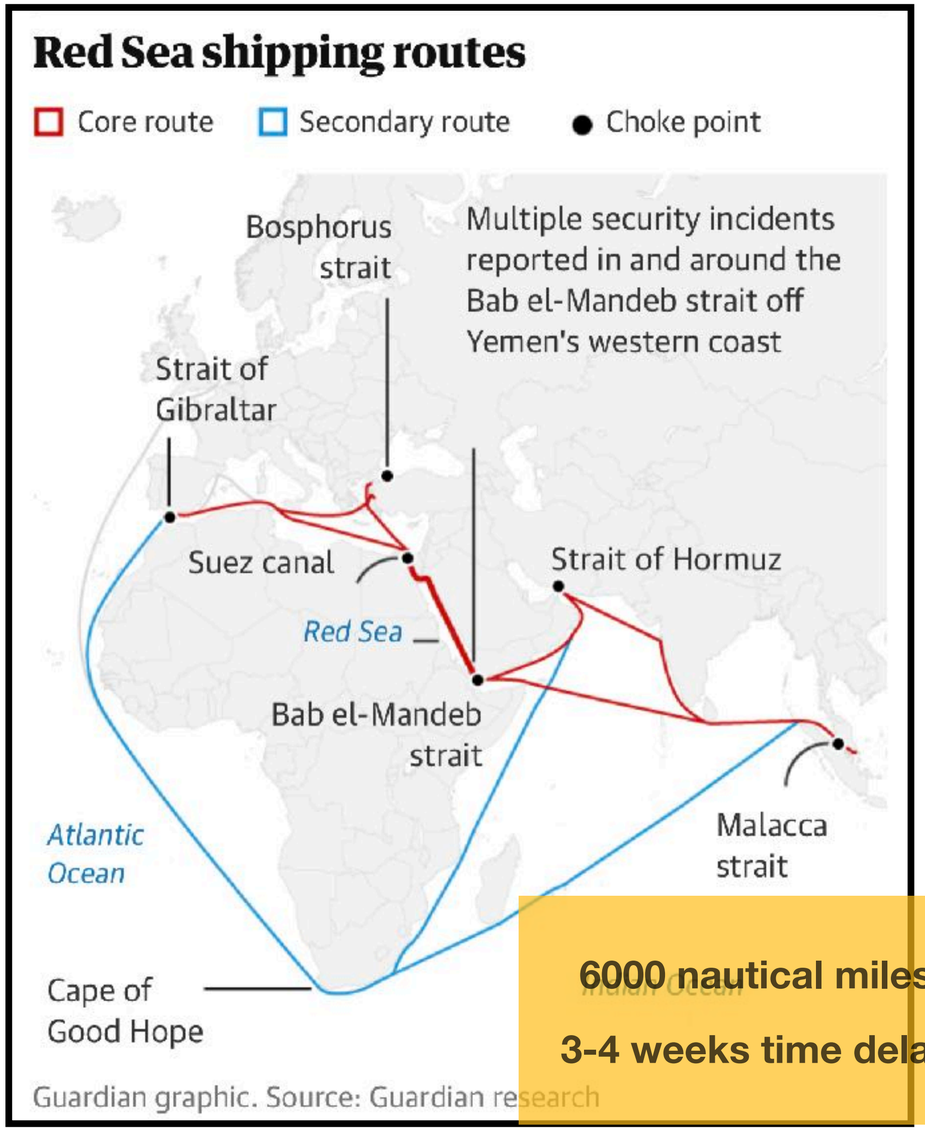


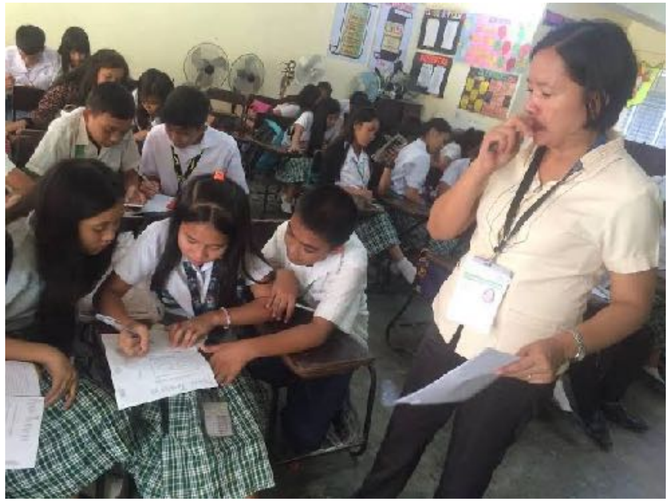
6000 nautical miles

3-4 weeks time delay

Fragility of Shipping - Winds and Pirates

PRE-PANDEMIC SYSTEMS OF SYSTEMS IN STABLE STATE

EDUCATION



MANUFACTURING

TOURISM

FOOD SYSTEMS

HEALTH CARE

THE PANDEMIC HAPPENED BUT OTHER DISASTER HIT

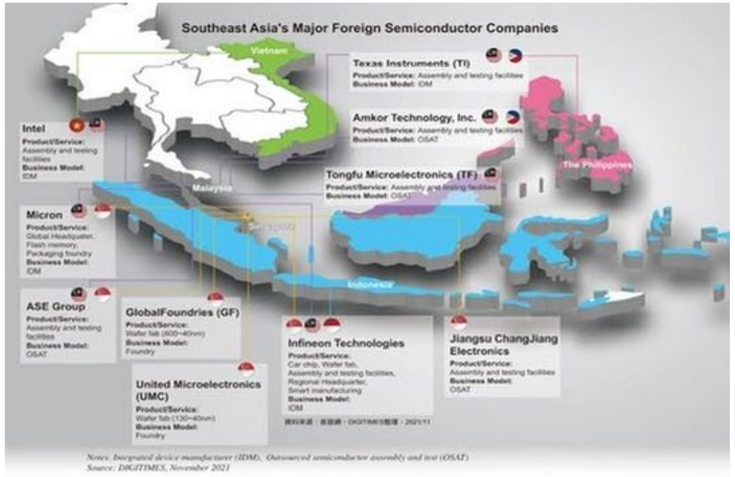
Water Shortage

Air Traffic Shutdown

Wild Fires

Earthquakes

Supply Chain Collapse



Floods

WE NO LONGER HAVE THE LUXURY OF DEALING WITH ONE DISASTER AT A TIME

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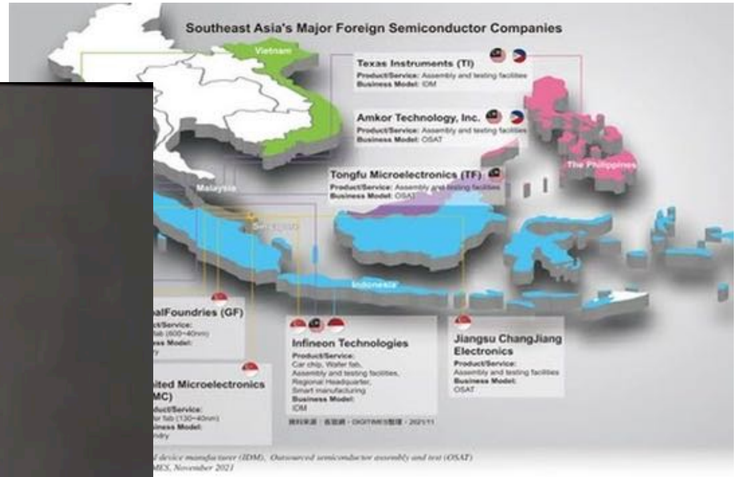


Floods

System Failure in an Avalanche of Crises

WE NO LONGER HAVE THE LUXURY OF DEALING WITH ONE DISASTER AT A TIME

Very Important Problem - Flood Resilient Smart City - Design in Disaster Resilience

How LITTLE Rainfall Will It Take so Travel to Hospital Will Take 3 X or 10 X Longer ?

How Long Before the Hospital is Isolated ?
- Personnel and Patients Can't Get There
- Few Can Leave

Where Would You Place a Second Critical Care Hospital ?

If We Evacuate the Hospital, When Should You Start ?

☆ Known Choke Points, Grow in Size

H Main Critical Care Hospital

Event after Event Monitoring / Data Collection

Monitor Using CCTV Cameras and Rain Gauges

Travel Speeds/ Times, Choke Point Flooding, and Rainfall to NO-GO

Pasig City Command Center

Courtesy of Solidmaps Davao

Sustainable Business

Philippines agrees 2,000-MW offshore wind deals with Danish investor

Reuters

March 30, 2023 7:22 PM GMT+8 · Updated 6 months ago

A general view of the DanTysk wind farm, 90 kilometres west of Esbjerg, Denmark, September 21, 2016. Picture taken September 21, 2016. REUTERS/Nikolaj Skydsgaard *Acquire Licensing Rights*

Will Extreme Weather Make This a Bad Investment ?

Can Offshore Wind Platforms Survive ?

Can We Quantify the Risks Involved ?

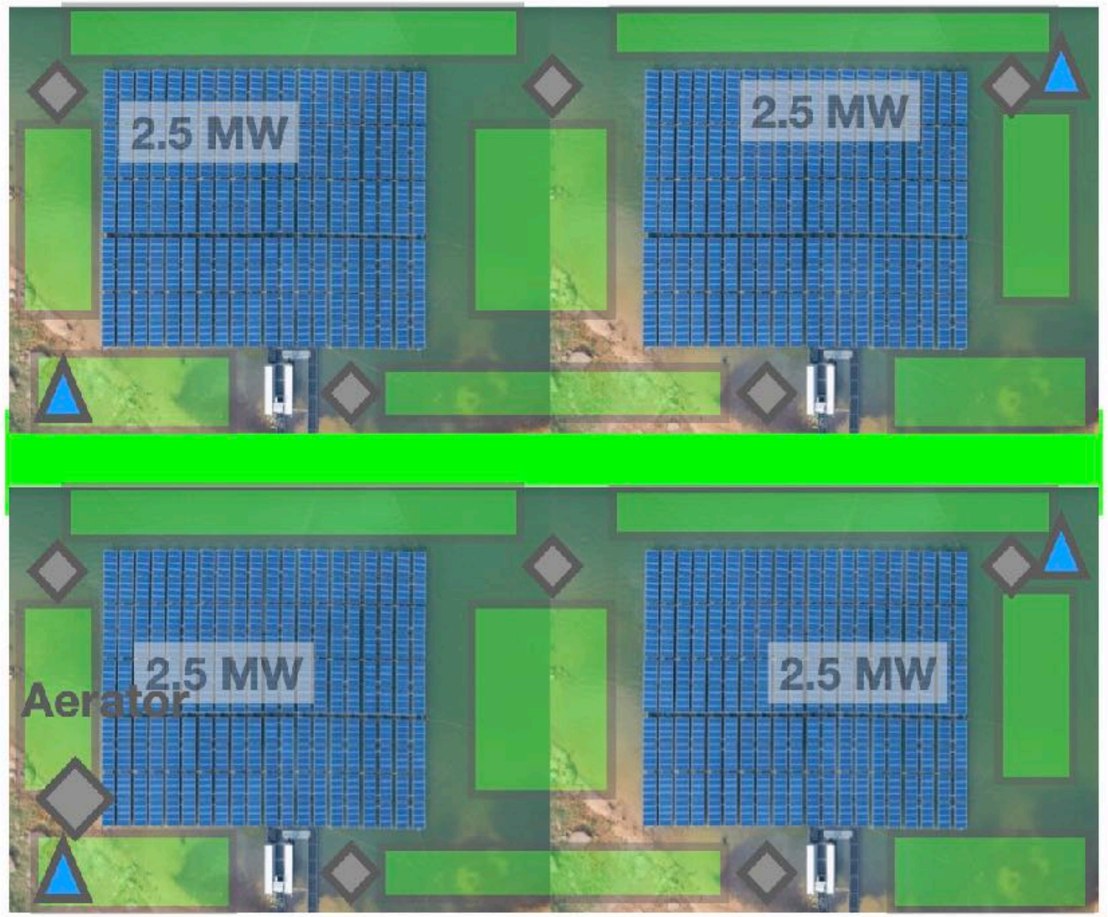
Risk Modeling Based on Extreme Value Statistics

Floating Solar Panels on Laguna Lake with Complementary Ecosystem and Field Servers

Netherlands Deployment

Potential of 10 GW Solar Production On Laguna Lake

Solar Power Plant (10 MW) With Floating Gardens, Aerators, and Field Server



Field Server

DO, pH, Conductivity
Turbidity, NPK
LoRa Gateway
Sampling

Aerator

Paddle Wheel
Micro-bubbler
Night Operation

Garden

Livelihood Crops
Reduce Excess Nutrients
Barrier for Sediments
Aquatic Filter Feeders

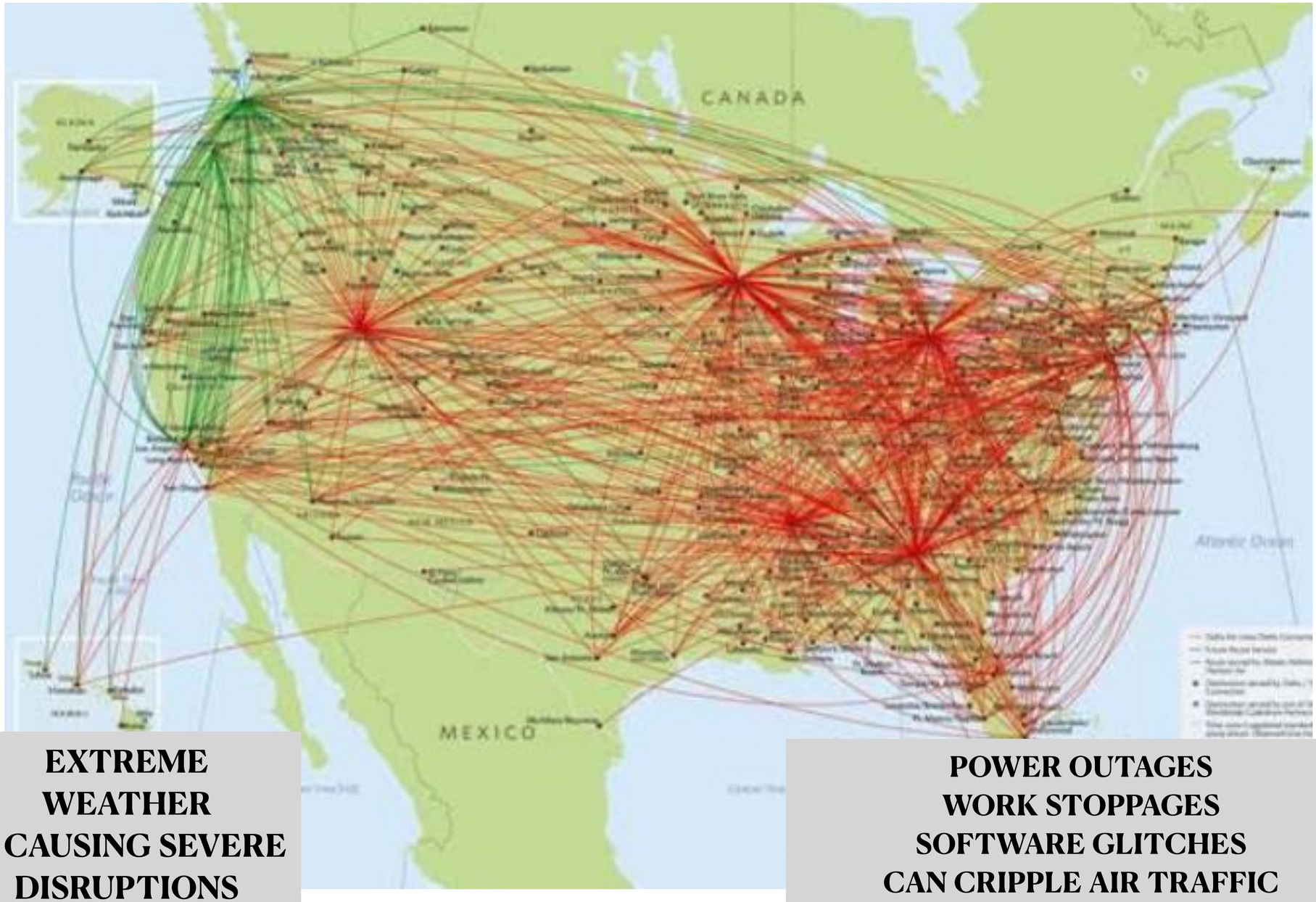
What Will Make This Investment Resilient Against Extreme Weather Events ?

THE HUB AND SPOKE SYSTEM OF AIR TRAFFIC

NATURE WORLD NEWS

US Travel Disruptions: Over 7,000 Flights Cancelled Or Delayed Due to Severe Weather Conditions

By Kenneth John Jun 27, 2023 09:47 PM EDT



EXTREME WEATHER IS CAUSING SEVERE DISRUPTIONS

POWER OUTAGES
WORK STOPPAGES
SOFTWARE GLITCHES
CAN CRIPPLE AIR TRAFFIC

IT HAS BECOMING VERY DIFFICULT TO MAINTAIN NORMAL OPERATIONS OF AIR TRAFFIC

Extreme Rainfall Over Airports

MicroClimate of Critical Infrastructure - Unknown

Difficult to Predict Extreme Rainfall in Small Area

Time Dependent Behavior of Visibility is Unknown

Systems Delay and Crash Risks - New Costs

Many Asian Airports Measure Real Time Visibility

Can New Measurements Fill The Void in Our Understanding of the New Dangers of Extreme Rainfall ?

Big questions on safety, pilot training after 5 Indian planes veer off runway in 3 days

The aircraft involved are SpiceJet and Air India Express. Half the incidents occurred in wet weather, for which airlines have to ensure their pilots undergo specific training.

Ifrah Mufti • 03 July, 2019 09:30 am IST

Five Planes Missed Runway in Heavy Rain !

Boeing Exec Jet Approaches Airport — Go Around —-> Can’t See Large Parts of the Runway

Video shows the jet having to go around another time in heavy rain conditions .

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Airport Runway ‘Disappears’ - Many Accidents in Asian Airports Due To Heavy Rain

PRESS STATEMENT: Korean Air KE631 Incident on MCIA Runway

Mactan-Cebu International Airport
Korean Air KE631 Incident
As of 24 October 2022, 3:00 A.M.

We confirm that at 11:11pm on 23 October Sunday, Korean Air flight no. KE631 from Incheon, South Korea overshot the runway in a landing attempt during heavy rains at the Mactan-Cebu International Airport (MCIA).

No one was hurt during the incident. All 162 passengers and 11 crew onboard the A330 aircraft were immediately evacuated and tended to by airport emergency personnel.

Urban Micro-Climate - Rain Distribution and Visibility

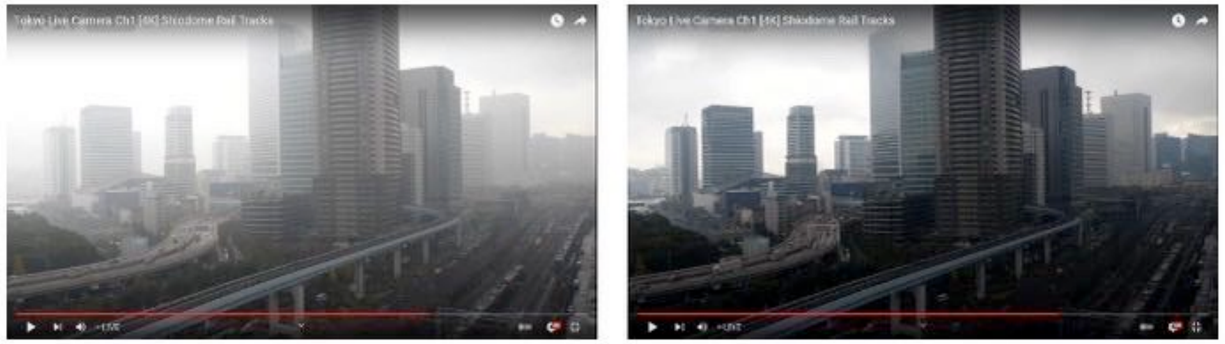

Figure 21. Minute 69 (left) and Minute 81 (right) at the Tokyo Site

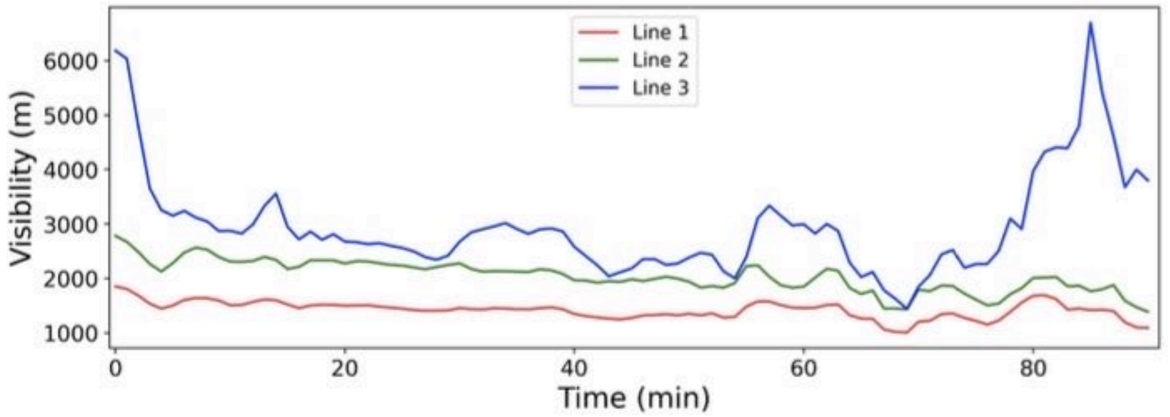

Figure 22. Line 1 (red), Line 2 (green), and Line 3 (blue) visibility measurements using Dual Target Approach at the Tokyo Site

Live Video Feed From Tokyo 4K Webcam
Katipunan Rd. Buildings

Michelle Malata Physics/MSE Thesis - Visibility Measurements with Smartphones

VISIBILITY CAMERAS FOR WILD FIRES ?

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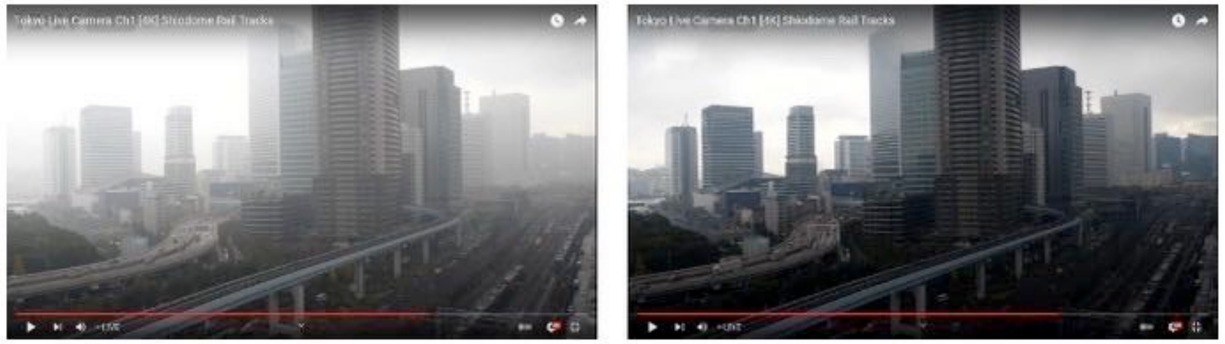

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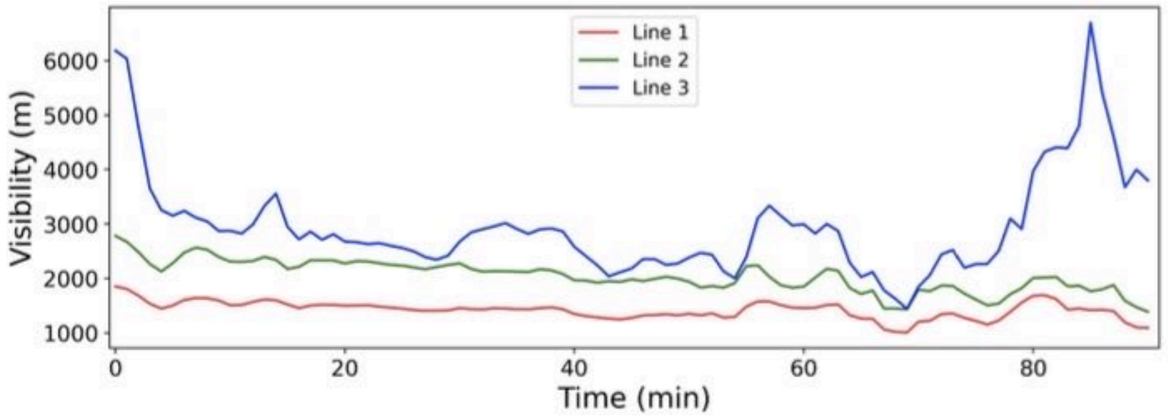

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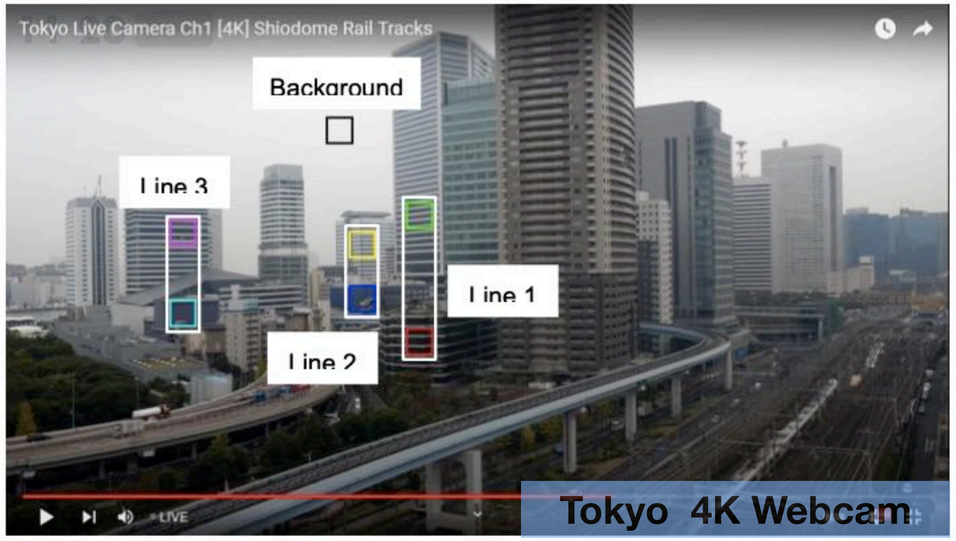

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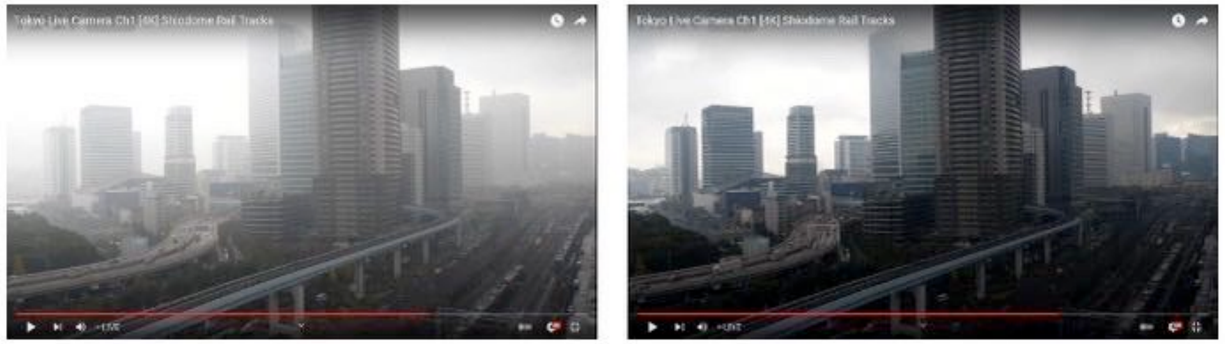

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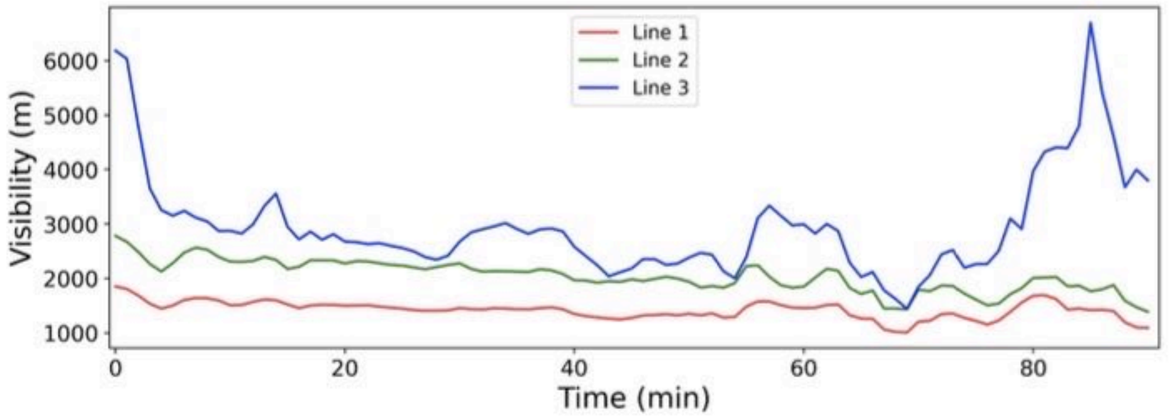

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VISIBILITY CAMERAS FOR WILD FIRES ?

SmartPhones and Streaming Cameras for Visibility Measurements

Katipunan

Figure 3.c. Patches (squares) for analysis taken from Katipunan site with different lines used for Dual Target Approach

Tokyo 4K Streaming Camera

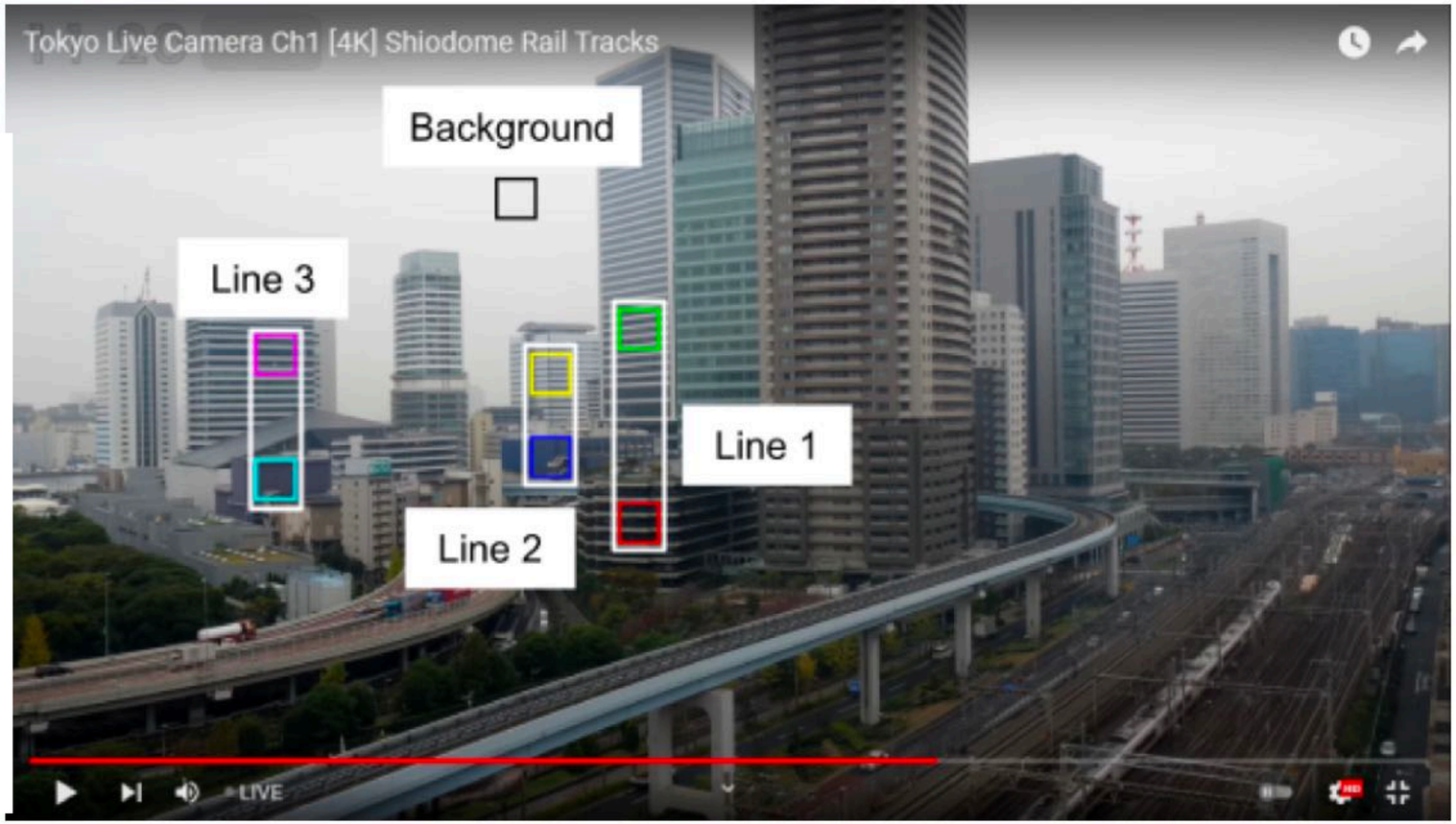


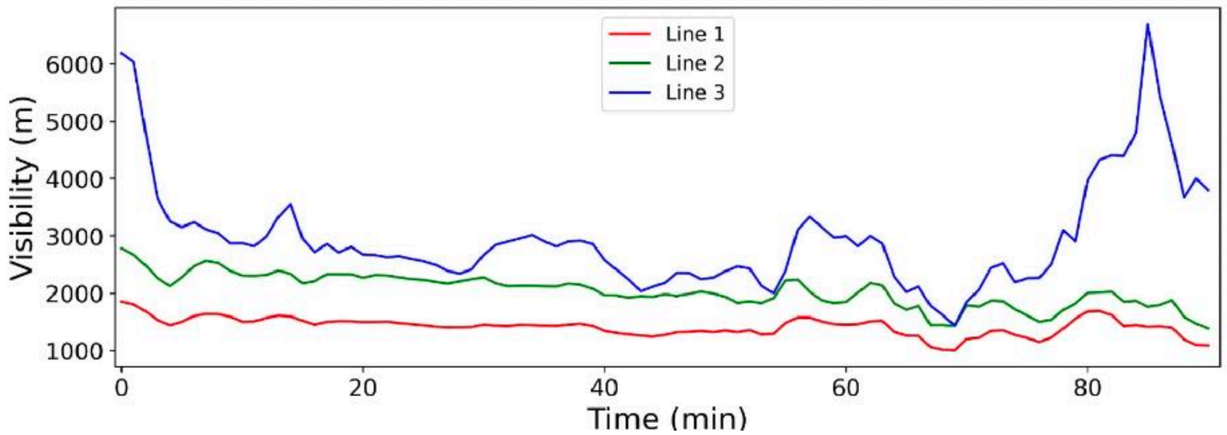
Figure 3.d. Patches (squares) for analysis taken from Tokyo site with different lines used for Dual Target Approach

after Michelle Malata Applied Physics Thesis 2022

We Should Have Visibility Cameras Installed in Major Philippine Airports

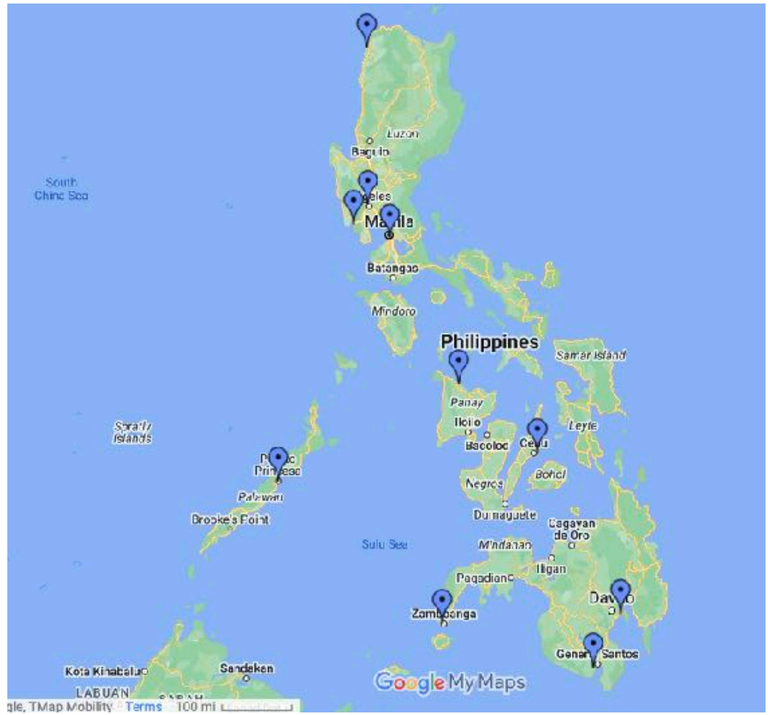
Visibility Reports 24/7 in Real Time

Visibility Forecasting Based on Time Series Data



Safe Air Travel in Extreme Weather

Accurate, Efficient Flight Scheduling Planning



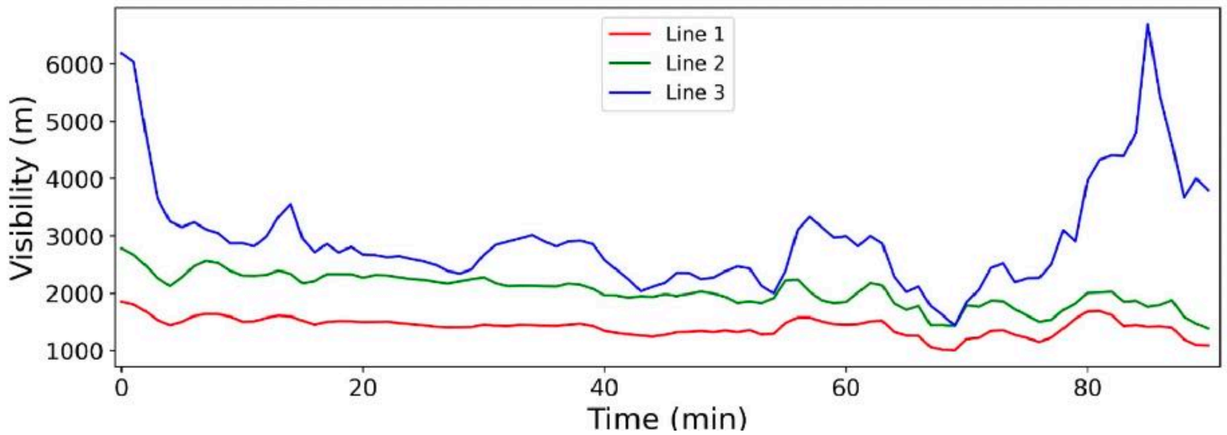
Network of Streaming 4K Cameras

Install Throughout ASEAN Partners

We Should Have Visibility Cameras Installed in Major Philippine Airports

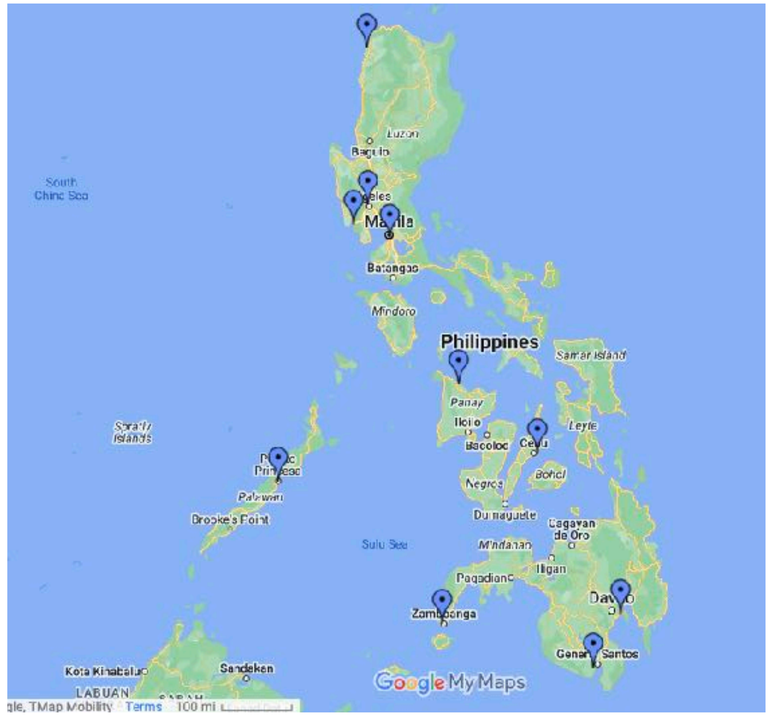
Visibility Reports 24/7 in Real Time

Visibility Forecasting Based on Time Series Data



Safe Air Travel in Extreme Weather

Accurate, Efficient Flight Scheduling Planning



Network of Streaming 4K Cameras

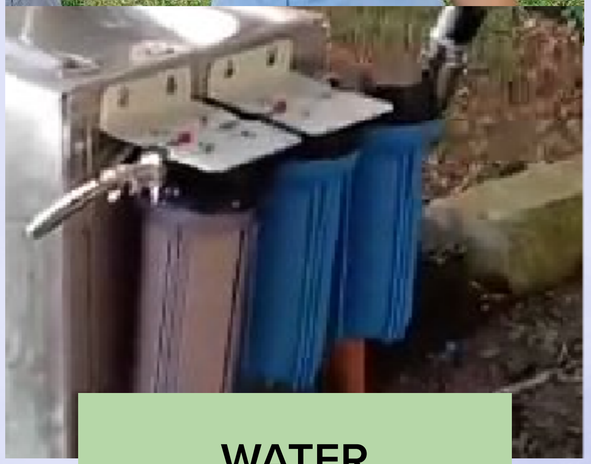
Install Throughout ASEAN Partners

FEWS NEXUS

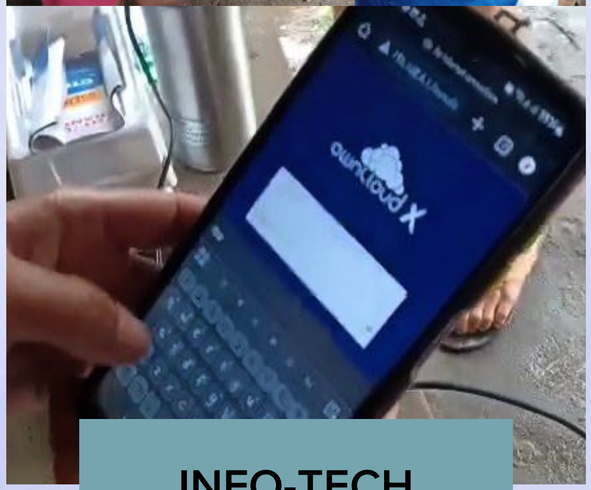
‘Nexus thinking’ promotes the inseparable links between the use of resources to provide basic and universal rights to food, water and energy security

FOOD

ENERGY



WATER



INFO-TECH

FEWS+ NEXUS

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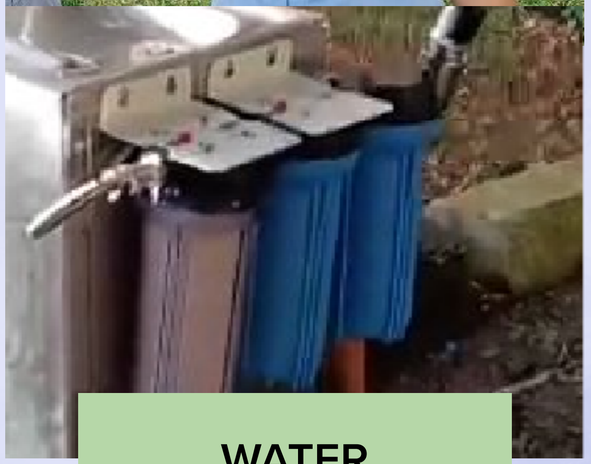
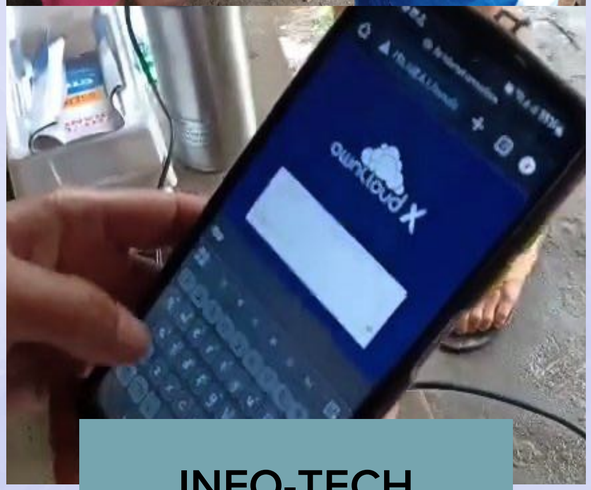
FOOD

ENERGY



WATER



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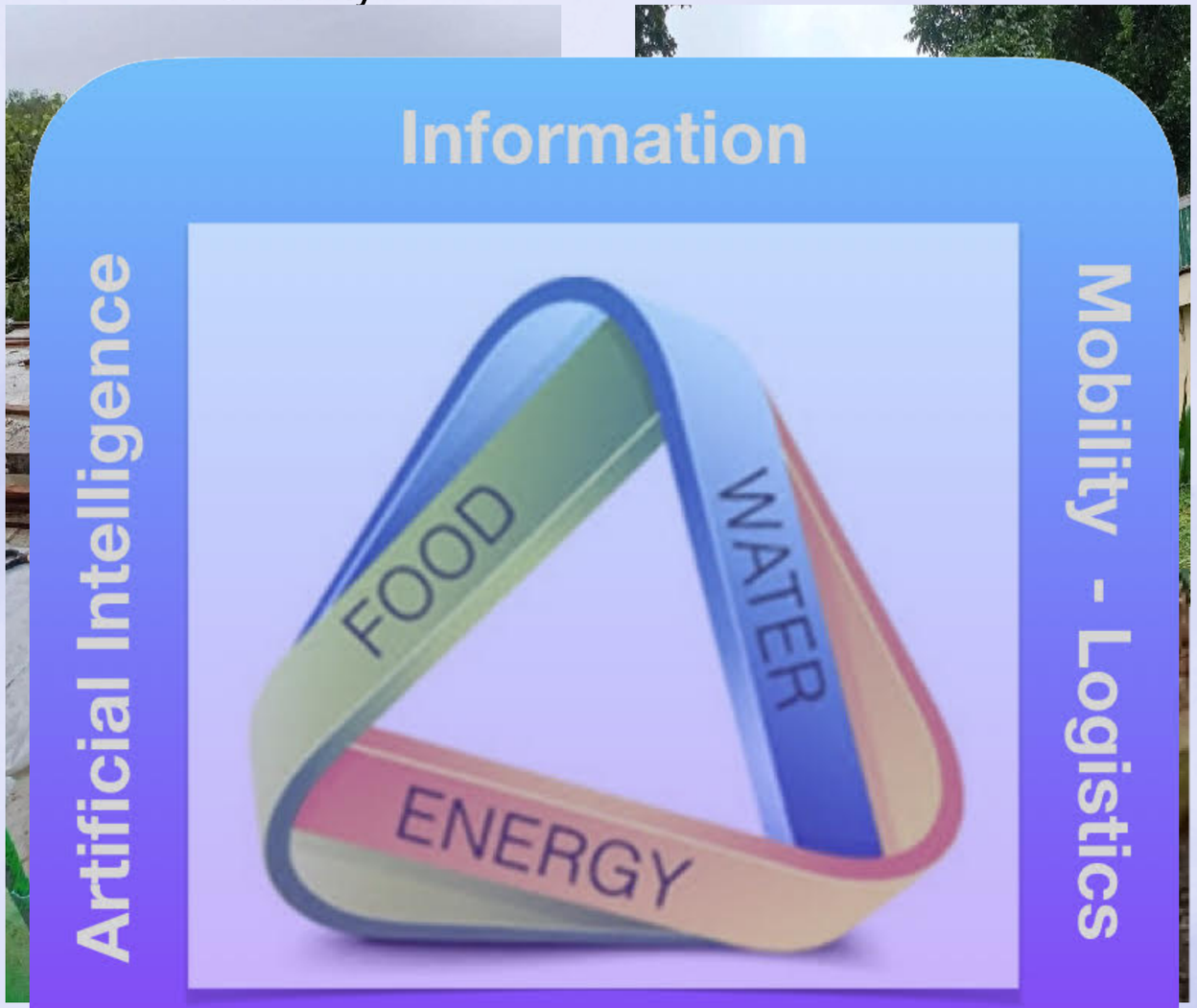
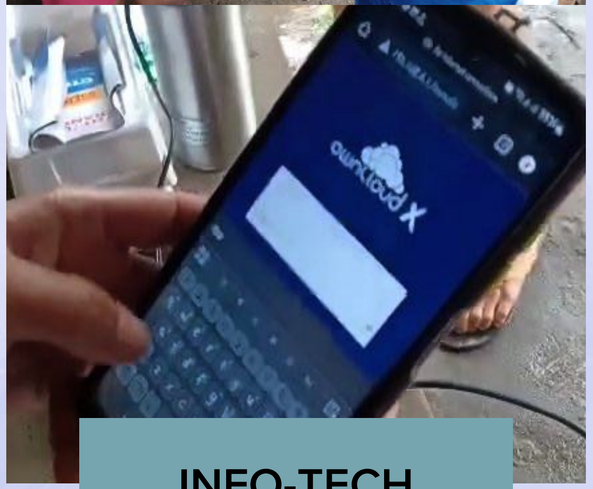




INFO-TECH

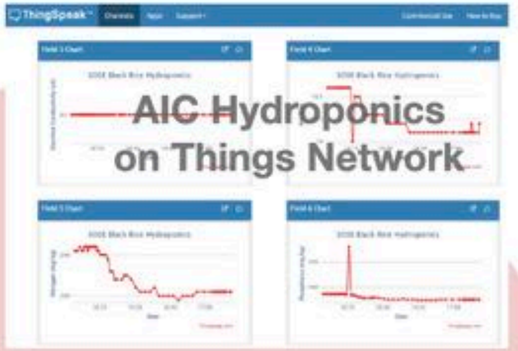
Rethinking the Feeding of a City

Urban Aquaponics - Vegetable + Protein Self Sufficiency

Pop-Up ‘Free’ Markets

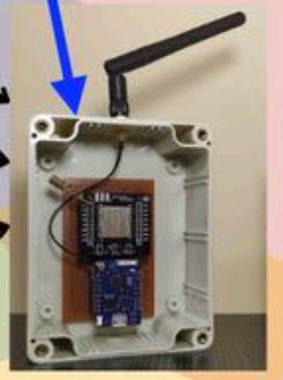
Can Cities Farm Fish and Vegetables at Scale ? H2O ?
What are the Breakthrough Technologies Needed ?

AIC Hydroponics with LoRa WAN Sensors and Starlink to Things Network



IoT Cloud Platform

INTERNET



LoRa

LoRa Gateway
(Wi-Fi 2.4GHz)

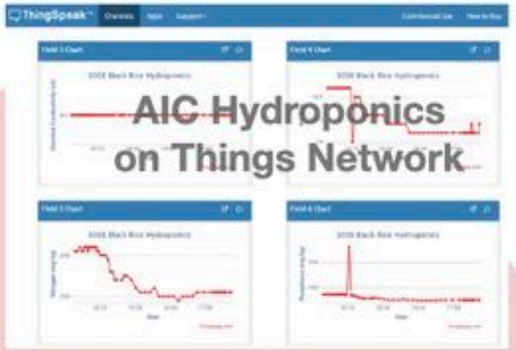
WLAN

AIC
Dashboard

Near Cloud
Server

Smart Farmer

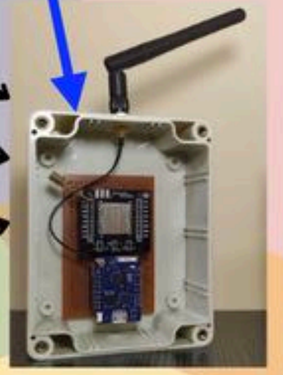
AIC LoRa WAN Sensors and Starlink Connextion to Things Network



IoT Cloud Platform

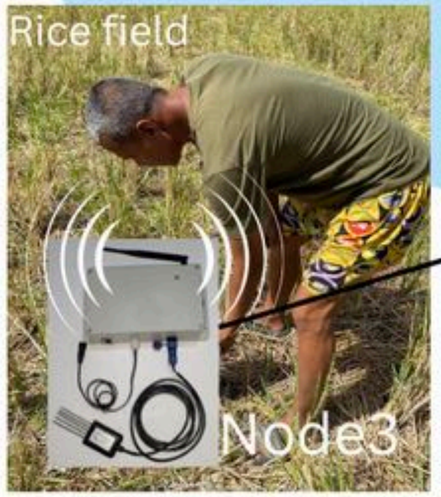
INTERNET

LoRa



LoRa Gateway
(Wi-Fi 2.4GHz)

WLAN

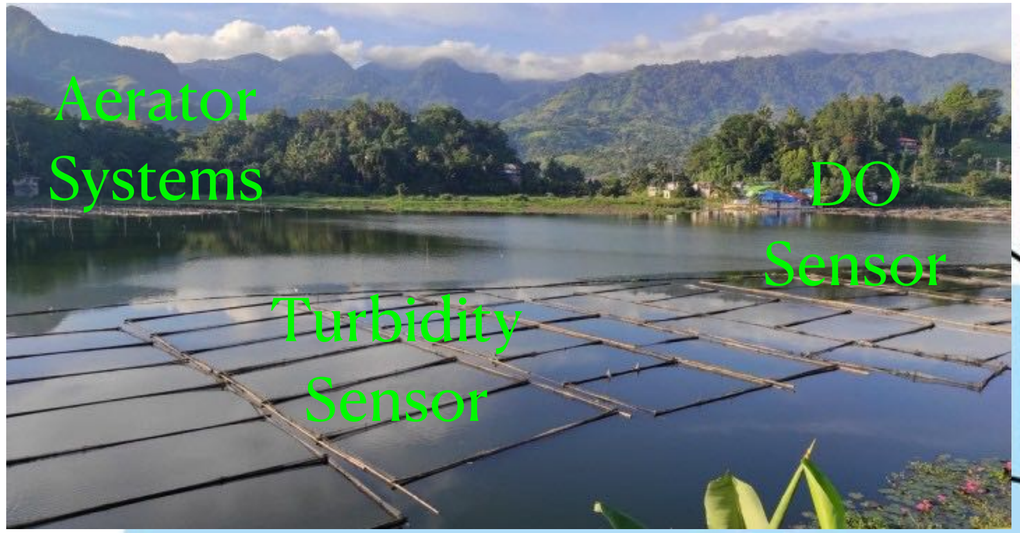


AIC
Dashboard

Near Cloud
Server

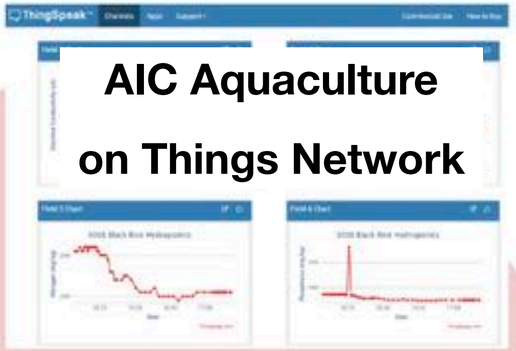
Smart Farmer

AIC LoRa WAN Sensors and Starlink Connextion to Things Network



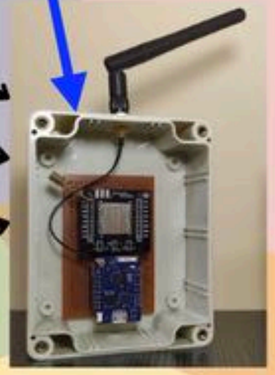
LoRa

STARLINK



IoT Cloud Platform

INTERNET



LoRa Gateway
(Wi-Fi 2.4GHz)

WLAN

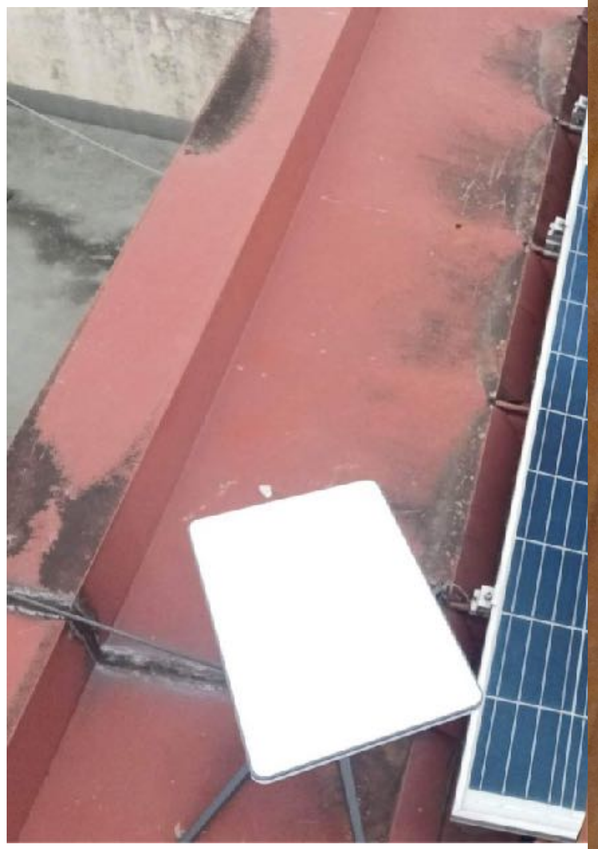
AIC
Dashboard

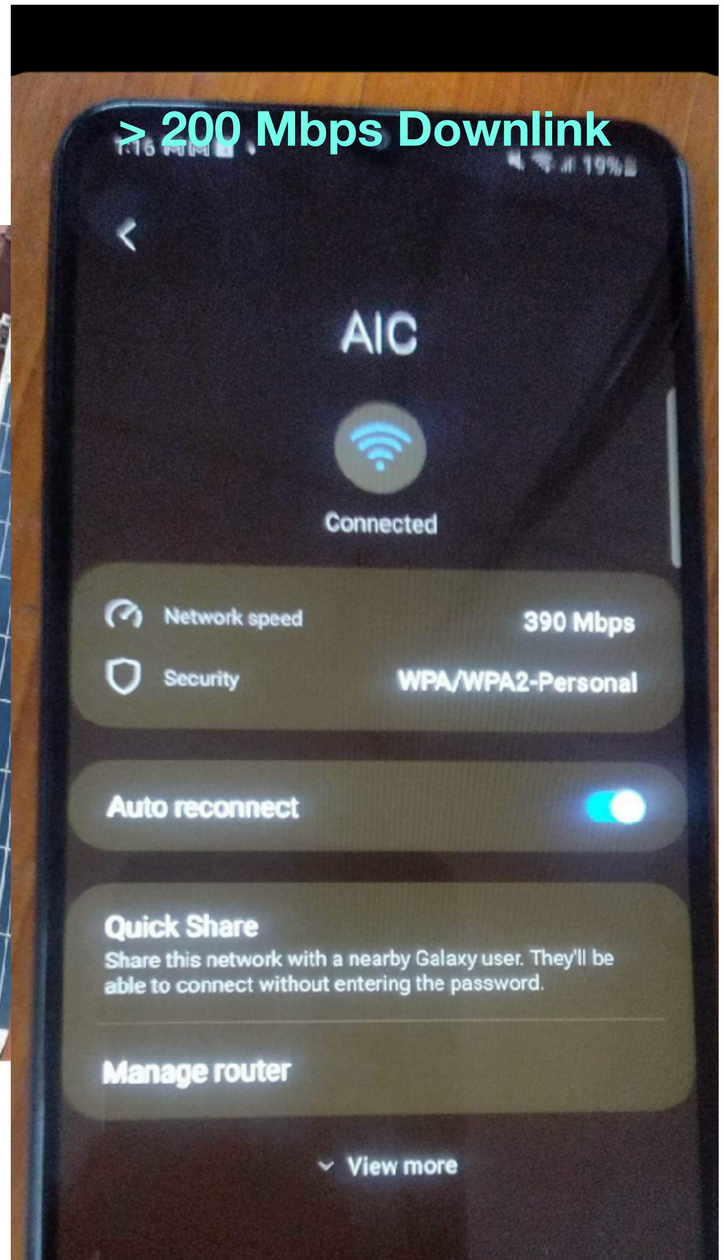
Near Cloud
Server

Smart Farmer

Starlink Connectivity Experiments

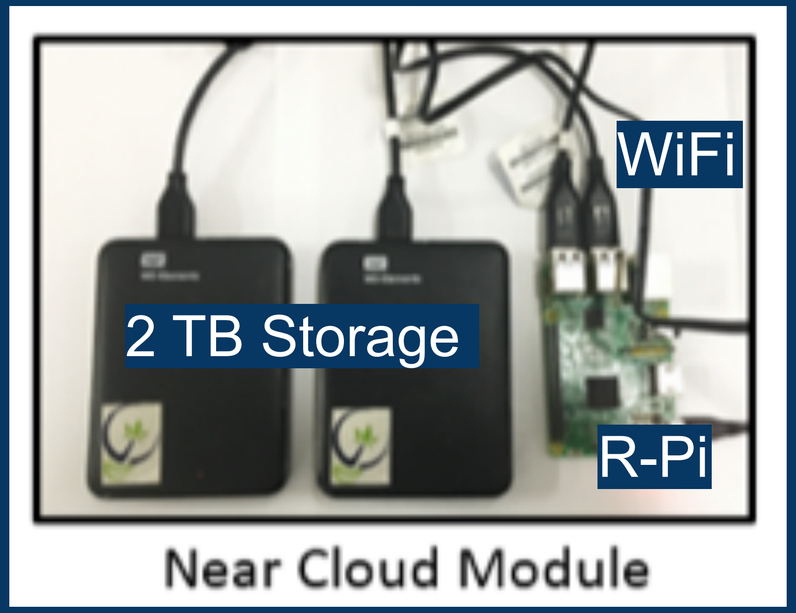
AIC Rooftop

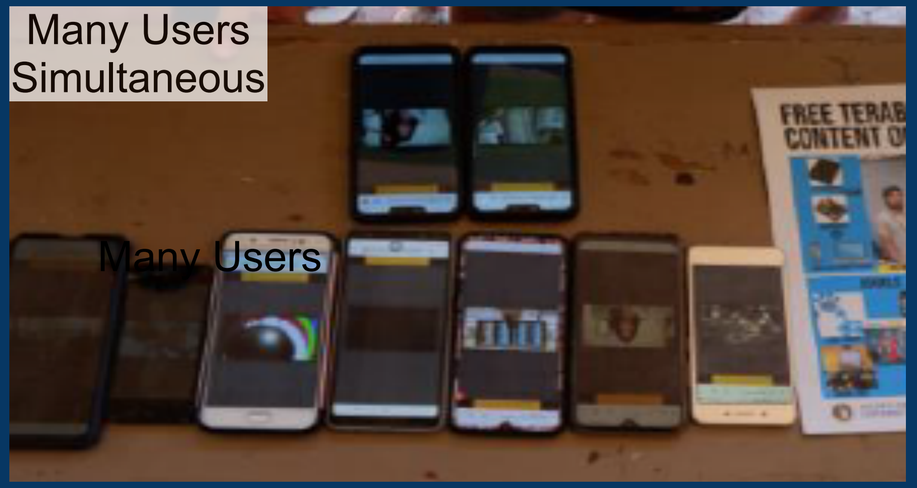




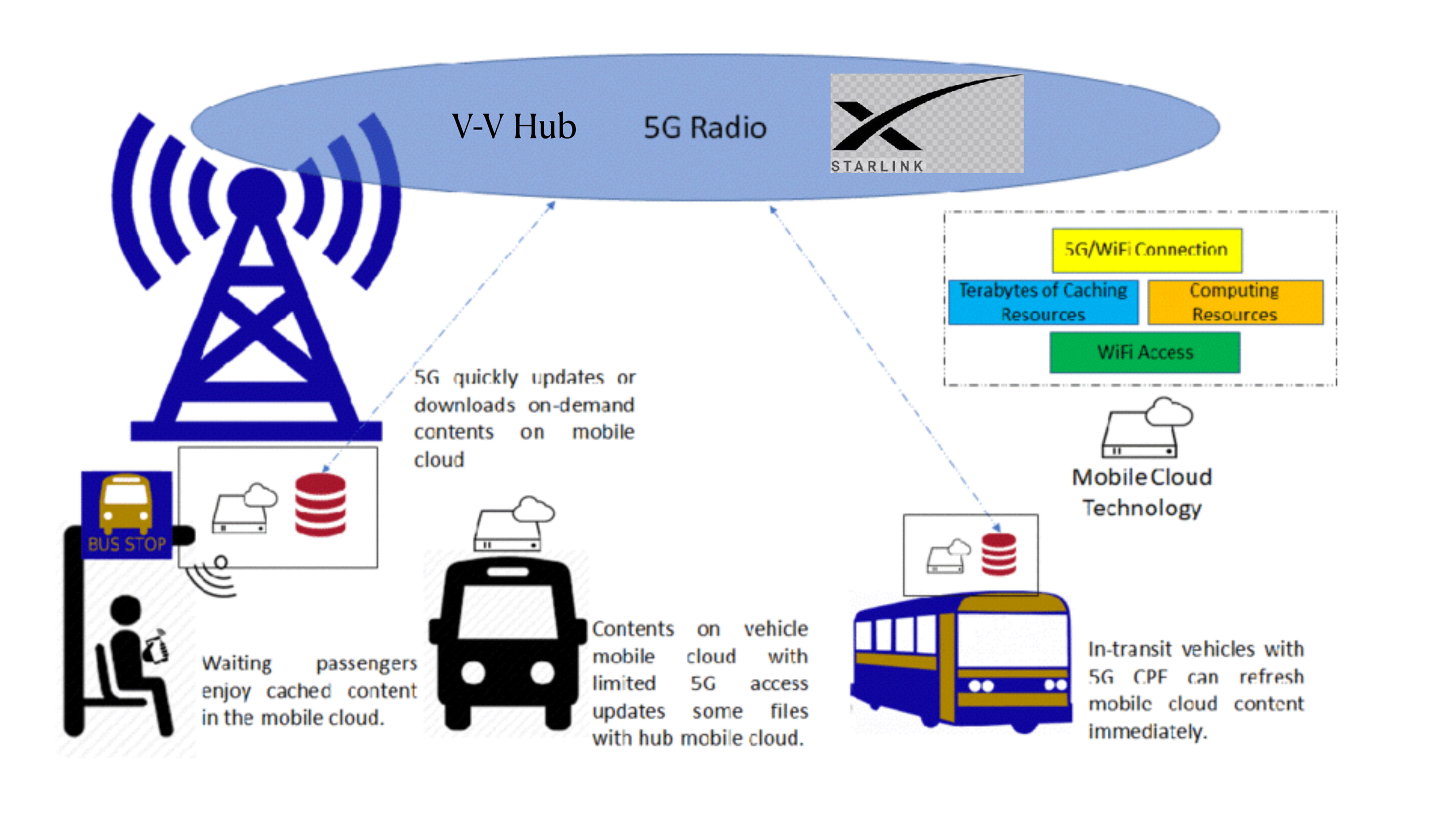
Mobile Unit

Mobile Cloud System for With TBytes on the Move / Computing





Streaming, Upload, Download On-the-Go


V-V Hub
5G Radio
STARLINK
5G/WiFi Connection
Terabytes of Caching Resources
Computing Resources
WiFi Access
Mobile Cloud Technology
5G quickly updates or downloads on-demand contents on mobile cloud
BUS STOP
Waiting passengers enjoy cached content in the mobile cloud.
Contents on vehicle mobile cloud with limited 5G access updates some files with hub mobile cloud.
In-transit vehicles with 5G CPE can refresh mobile cloud content immediately.

ATENEO DE MANILA UNIVERSITY

Ateneo Innovation Center

Try TeraBytes of Preloaded Content on our Mobile Cloud

Why Mobile Cloud?

- Low Cost
- Terabyte Storage
- Cached Content
- Low Power
- Computing Services

Try It Now!

1. Connect to AIC
   SSID: **AIC_NearCloud**
   Password: **onebigfight**
2. Go to http://192.168.1.1/owncloud
3. Click on the folder and/or file.

Schools

Library

Video

KNOWLEDGE CHANNEL

Tutorial

MATH, SCIENCE, AND ENGLISH TUTORING

Courses

Visual Aids

Curriculum

Vehicles

Navigation

V2X Comms

Entertainment

TOY STORY 4

Training Modules

Training on the go!

Big Data

Digital Signage

Corporate/LGU

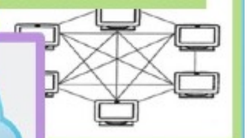
Disaster Response

High-Resolution Maps for Land Use, Flooding, etc.

Computing Services

Safe Storage

Mesh Network



5G

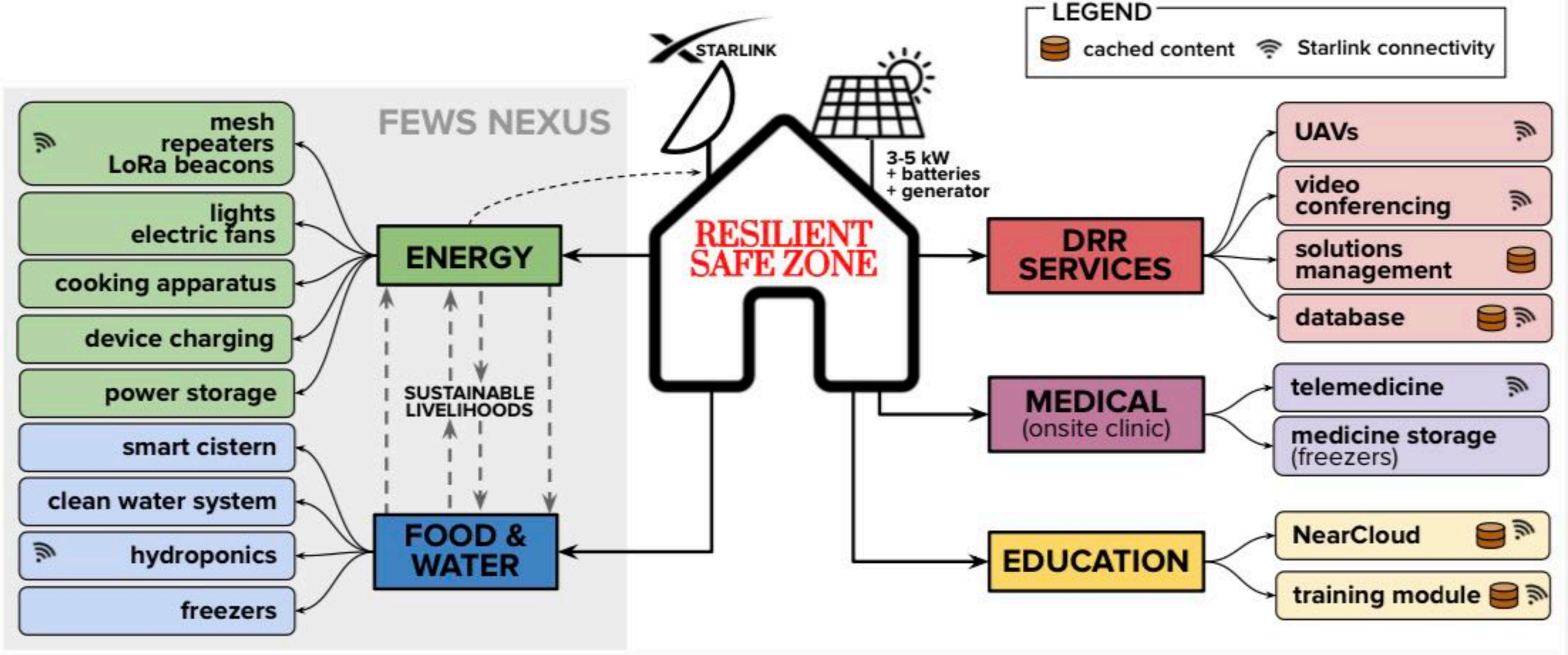
Healthcare

Sensor Network (Agriculture)

SAFE ZONE/EMERGENCY CENTER SYSTEM DESIGN

100 Families | Solar Power | Starlink Connectivity | Food | Energy | Water | InfoTech

PRE-DISASTER	DISASTER	POST-DISASTER
Prevention and Preparedness	Response	Recovery and Learning



JOY ROCAMORA (NRC/AIC) WILL PRESENT ON RESILIENCE HUB DESIGN

WELCOME TO INNOVATION AND TECHNOLOGY CLASS

Dr. GREGORY TANGONAN AND DR. LEA MACARAIG
ATENEO INNOVATION CENTER

Assignment 1 - Part One

Timeline of The Past Three Years during the Pandemic

Describe the Technologies that Made a Big Difference

Share Your Progress / Ideas on Slack

Teach New Science Impactful Ideas Well Explained

Assignment 1 - Part Two

Top 35 Innovators Under 35 - Innovator's Mindset

Describe the Contributions These Innovators Made

Relevance to Understanding Complex Systems / Problems

Each Group will present two parts - four minutes -four charts presentations.

Combined talk submitted as voice over of less than eight minutes. .

Wicked Problems - Embrace the Realities of Complexity

Systems theory emphasizes the interrelationships and dependencies within systems, and how changes in one part can affect the whole.

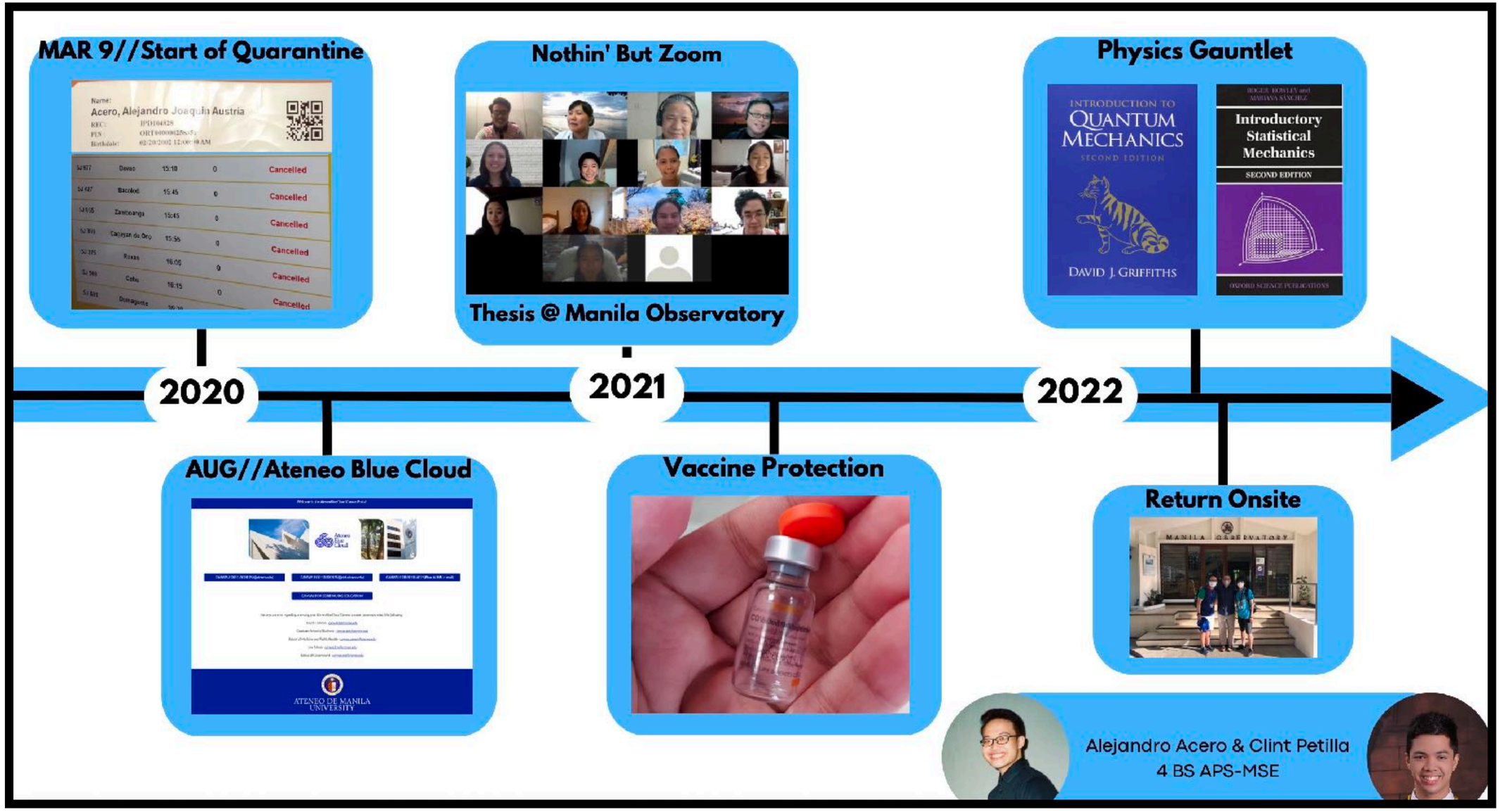
Extreme events can trigger downstrean\

A major disaster, like the pandemic, is a prime example of a wicked problem. The pandemic led to a cascade of issues:

- **Mass loss of jobs**: The pandemic's impact on businesses led to widespread unemployment, affecting economic stability and individual livelihoods.
- **Supply chain disruptions**: Lockdowns and restrictions hindered the production and distribution of goods, leading to shortages and economic impacts.
- **Remote learning**: The shift to online education posed challenges for students, educators, and families, impacting the quality of education and social development.
- **Stress on medical personnel**: The unprecedented health crisis placed immense pressure on medical staff, leading to burnout and affecting healthcare systems.
- **New Understanding of Work**: Work - Home Life Balance becomes very important, new work organizations with higher productivity for some, early retirements
- **Need to Stay Connected and Informed:**

These interconnected challenges illustrate how a wicked problem like a pandemic doesn't exist in isolation. Its effects ripple through various systems, creating a complex web of new problems and exacerbating existing ones. The current understanding in systems theory is that addressing a wicked problem requires holistic, adaptive, and multi-faceted approaches, acknowledging the interconnected nature of these issues and the potential for solutions to lead to unintended consequences.

Key Events in Students' COVID Timelines

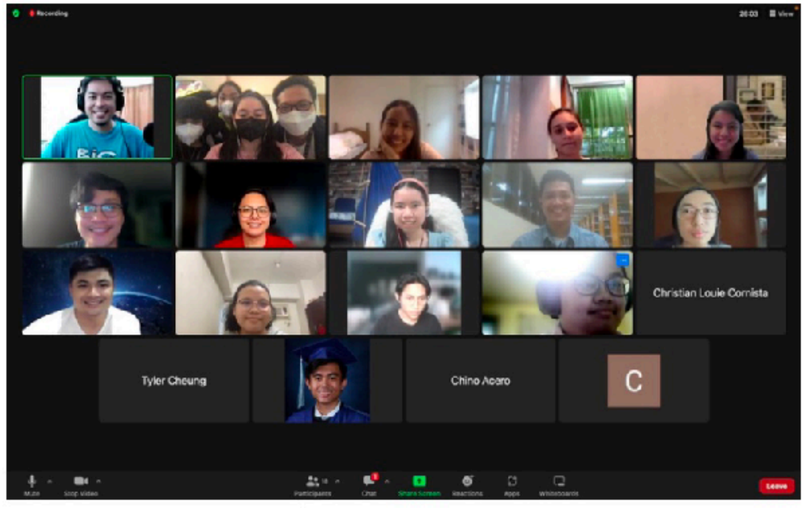


What Technical Innovations Had The Greatest Impact During the Pandemic ?

Technologies that Helped

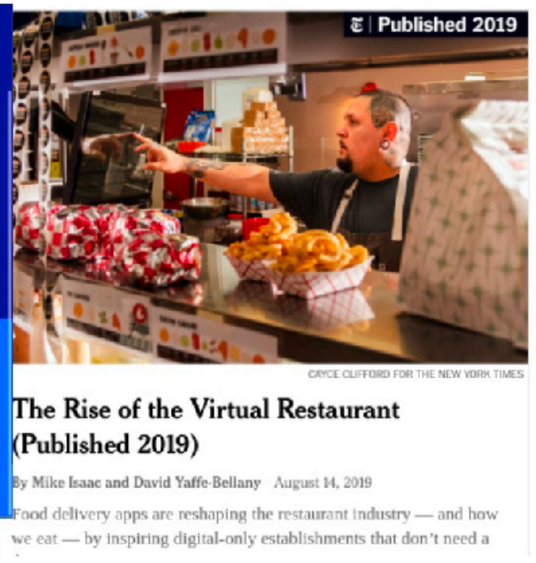
Communication & Collaboration

- ZOOM, Google Meet, Discord, Skype
- Google Drive, Google Docs
- Canvas, Google Classroom
- Coursera



Lifestyle & Health

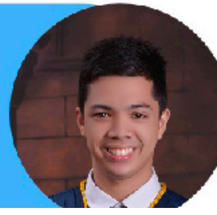
- QR codes replacing the health declaration form
- Vaccines and boosters
- Masks and air purifiers
- Food delivery services


T | Published 2019
CAYCE CLIFFORD FOR THE NEW YORK TIMES
The Rise of the Virtual Restaurant (Published 2019)
By Mike Isaac and David Yaffe-Bellany August 14, 2019
Food delivery apps are reshaping the restaurant industry — and how we eat — by inspiring digital-only establishments that don't need a

References

https://www.afterschoolafrica.com/49435/google-meet-vs-zoom-which-is/
https://s-pass.ph/
https://news.uchicago.edu/story/how-were-researchers-able-develop-covid-19-vaccines-so-quickly
https://www.adjust.com/blog/food-delivery-apps-thrive-following-covid-growth/

Alejandro Acero & Clint Petilla
4 BS APS-MSE



A New Food Experience

Frozen Food

Family-sized Meals

DIY Kits

References

https://www.yummy.ph/news-trends/where-to-buy-jollibee-ready-to-cook-food-a00260-20200403
https://ilovetoeatph.wordpress.com/2020/04/24/your-tgifridays-and-italiannisready-to-cook-favorites-are-now-available/
https://philstarlife.com/living/109597-diy-food-kits
https://awesome.blog/2020/06/the-best-meal-kits.html

Alejandro Acero & Clint Petilla
4 BS APS-MSE

The Issue: Various levels of community quarantine

shifting guidelines confused people which discouraged errands with no reason due to risk of catching & spreading the virus

BUSINESS ESTABLISHMENTS/ ACTIVITIES	LEVEL 4
OUTDOOR DINE-IN SERVICES (AL FRESCO)	**30%** REGARDLESS OF CUSTOMERS' VACCINATION STATUS PROVIDED THAT **ALL EMPLOYEES ARE FULLY-VACCINATED**
INDOOR DINE-IN SERVICES	**10%** ONLY FOR **FULLY-VACCINATED INDIVIDUALS** PROVIDED THAT **ALL EMPLOYEES ARE FULLY-VACCINATED**

HOME QUARANTINE PASS COLOR CODING*

EO. 55 | DECEMBER 1-31, 2020

- MONDAYS, THURSDAYS & SATURDAYS
- TUESDAYS, FRIDAYS & SUNDAYS
- MONDAYS, WEDNESDAYS & SATURDAYS

The Result: STUCK IN OUR HOMES

people still have the same need for food and water
access to these resources is restricted at home

Grab
foodpanda
maxim
LALAFOOD
tok tok
PICK·A·ROO
zomato

The Solution: Delivery Services

connection between people and channels of distribution was severed
courier services step up and fill the role of middle man
whatever you can buy online can be delivered to you

References
https://www.adjust.com/blog/food-delivery-apps-thrive-following-covid-growth/
https://www.intelivita.com/blog/food-delivery-business-model/
https://www.facebook.com/photo?fbid=4999591280070493&set=pcb.4996462770383344

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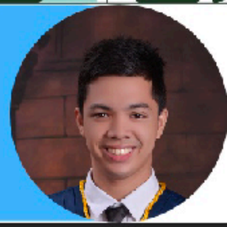
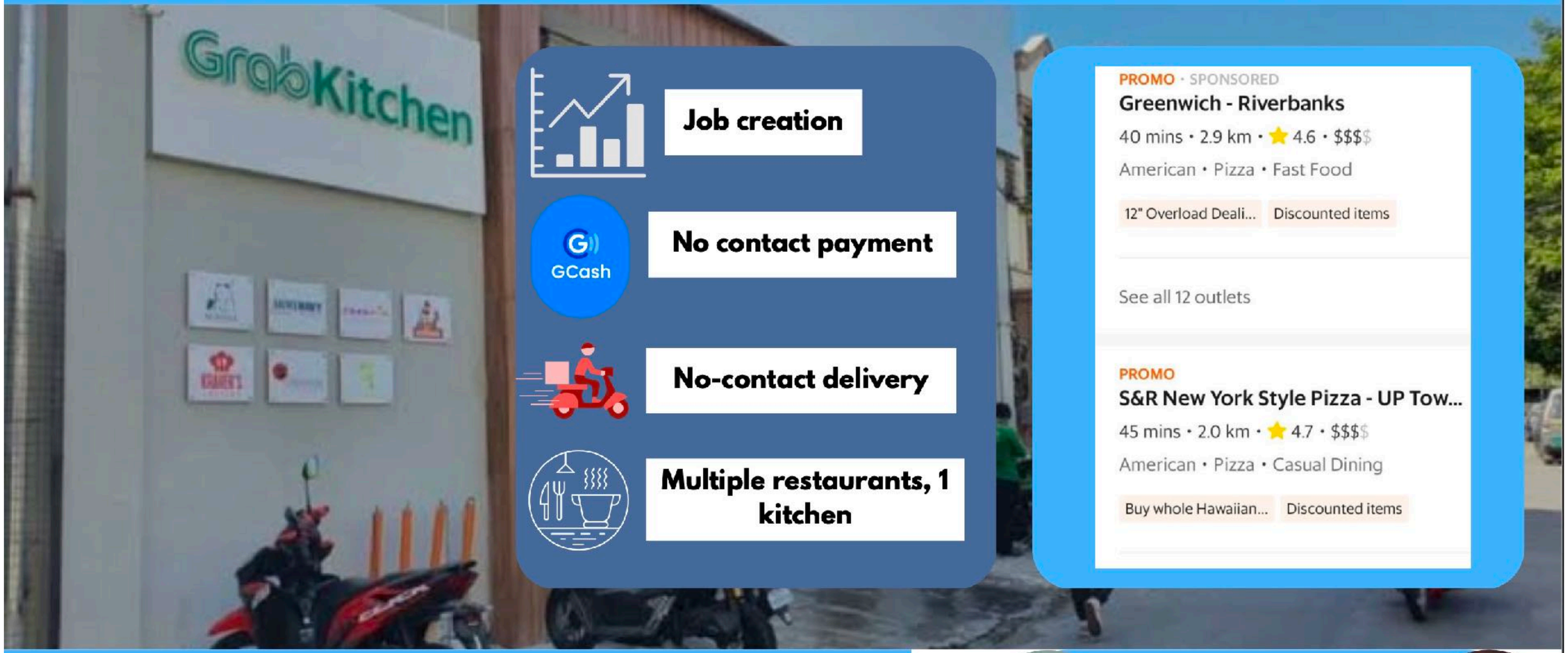


The Virtual Kitchen and the Infinite Menu



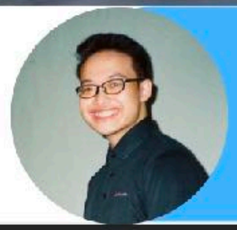
- **Job creation**
- **No contact payment** (GCash)
- **No-contact delivery**
- **Multiple restaurants, 1 kitchen**

PROMO · SPONSORED
Greenwich - Riverbanks
40 mins • 2.9 km • ⭐ 4.6 • $$$$
American • Pizza • Fast Food
12" Overload Deali... | Discounted items

See all 12 outlets

PROMO
S&R New York Style Pizza - UP Tow...
45 mins • 2.0 km • ⭐ 4.7 • $$$$
American • Pizza • Casual Dining
Buy whole Hawaiian... | Discounted items

References
https://philstarlife.com/living/109597-diy-food-kits



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